The

Kentucky Geological Survey

WILLARD ROUSE JILLSON
DIRECTOR AND STATE GEOLOGIST

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Road Materials of Kentucky

1924

ALONG THE MAYO TRAIL NEAR PINEVILLE

Some of the best roads in Kentucky are now to be found in the mountains. This view on the Mayo Trail (Pineville to Ashland) is between Pineville and Paige in Bell County on Pine Mountain. The road is constructed of Kentucky materials. a limestone base surfaced with rock asphalt from Edmonson County.

THE ROAD MATERIAS OF KENTUCKY

A Preliminary Report Covering Field and Laboratory Investigations of Rock, Gravel, and Bituminous Sandstone Deposits Occurring Within the Commonwealth.

BY

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Author of

Economic Geology
Building Stones and Clays
Glass Sands of Kentucky
Building Stones of Kentucky, etc.

Illustrated with Forty-eight Photographs, Maps and Diagrams

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Letter of Transmission

Dr. Willard Rouse Jillson,
Director and State Geologist,
The Kentucky Geological Survey,
Frankfort, Kentucky,

and

Joe S. Boggs,
State Highway Engineer,
Department of State Roads and Highways,
Frankfort, Kentucky.

Dear Sirs:

Permit me to transmit herewith my illustrated manuscript entitled, The Road Materials of Kentucky.

The field work for the preparation of this report has extended over the summers of 1920, 1921, 1922, 1923. During the first three seasons named the work was done while prosecuting field investigations on the "Glass Sands of Kentucky" and the "Building Stones of Kentucky," both of which studies have been published. During the present season the time has been devoted entirely to an investigation of the road building materials of Kentucky. Every county in the State has been visited, but all the possibilities of road building materials have not been investigated for lack of time.

It is hoped that this report will contribute somewhat to the literature of the country on road building materials and prove of service not only to the Department of State Roads and Highways which cooperates with the Kentucky Geological Survey in its preparation, but also to the entire State of Kentucky in the betterment of its roads and the saving of money in the cost of its construction and maintenance of thoroughfares.

Respectfully submitted,
CHARLES H. RICHARDSON,
Assistant Geologist

Frankfort, Ky.,
Sept. 15, 1923.

Preface

The object in preparing this preliminary report upon the road building materials of Kentucky is mainly to present to the Kentucky Department of State Roads and Highways, Kentucky Road Engineers and Contractors, Fiscal Courts, Boards of Trade, Chambers of Commerce, and others more or less unfamiliar with the qualitative and quantitative features of the road building resources of Kentucky, some information of general interest and economic value upon the abundance of road building materials within the State.

The study of this problem has been carried on by the Kentucky Geological Survey and the Department of State Roads and Highways working in cooperation. Prior to its execution, there existed no definite report dealing directly with the road building materials of Kentucky.

In connection with this work, Dr. Richardson has visited each of the one hundred and twenty counties within the State. An effort has been made to reach as many quarries as possible and to discriminate between those quarries that are admirably adapted for building stone and decorative interior work, and those best used in the production of road metal. An investigation has also been made of many of the rock asphalt deposits of the State to ascertain their relative distribution, abundance, content of bitumen and adaptability as road surfacing material. The Ohio River gravel deposits, the gravels of the Jackson Purchase and many inland areas were also visited.

Many photographs have been taken in the field which appear as half-tone illustrations in this work. Over 400 samples from the different quarries were collected, trimmed to the size of hand specimens, labeled, and placed on exhibition in the museum of the Kentucky Geological Survey. Many samples of not less than 40 pounds in weight have been sent to Prof. D. V. Terrell, State Testing Laboratory, Lexington, Ky., that the value of these products as road metal may be definitely known. Samples of rock asphalt and gravel have

also been collected and sent to Professor Terrell. Many small rock samples have been collected from which microscopic slides, one-thousandth of a millimeter in thickness, may be made for study under polarized light at a later date if funds for this work are provided by the State.

W. R. Jillson

Director and State Geologist.

Frankfort, Ky.,
Nov. 1, 1923.

Acknowledgment

I wish to acknowledge my indebtedness to Dr. Willard R. Jillson, State Geologist, Mr. Joe S. Boggs, State Highway Engineer, and Mr. James T. Madison, Office Engineer, for their many suggestions and hearty cooperation; to Prof. D. V. Terrell, State Testing Laboratory, Lexington, Ky., for testing materials collected; to his assistants, Prof. J. A. Bitterman and Mr. J. R. Drummy, for their aid in the investigation of laboratory reports; to Prof. Arthur M. Miller, Professor of Geology, University of Kentucky, Lexington, Ky., for his assistance in locating quarries and his helpful suggestions; to Dr. Alfred M. Peter, of the Experiment Station, Lexington, Ky., for a large number of chemical analyses of limestones, sandstones and rock asphalt; to the district engineers, county road engineers, and all other engineers, county judges, boards of trade, chambers of commerce, and superintendents of quarries for their timely assistance and respective courtesies, and to all others who in any measure have aided in the preparation of this work.

CHARLES H. RICHARDSON,
Assistant Geologist.

Sept. 15, 1923.

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CHAPTER I.

INTRODUCTION.

A part of the field work upon which this report is based was done during the summers of 1920, 1921, and 1922, in conjunction with the published investigations of the Glass Sands of Kentucky, and Building Stones of Kentucky. During the months of June, July, August and September, 1923, new field investigations have been devoted entirely to the study of road building materials—the limestones, sandstones, rock asphalt and gravel deposits of Kentucky. The rock quarries visited this summer are chiefly situated along the lines of proposed Federal highways, State highways and county roads. The reason for such selection can be found in a desire to discover new quarry possibilities of valuable road metal situated near new road projects. Many of the rock asphalt deposits within the state have been visited, their geographical position noted, and their bituminous content determined. A number of gravel deposits have been located along the Ohio River and some of its tributaries. The bank gravels of the Jackson Purchase and many others outside of the Purchase have been studied to determine their suitability for the coarse aggregate of concrete and for hard surfacing of highways. It is expected that all of the above types of deposits will find expression upon a State map like the geologic map of Kentucky upon which all of the coal mines of the State are located. In the present report these quarries and pits have been located upon five regional maps.

The State of Kentucky naturally divides itself into five distinct districts, or provinces, for investigation and description of its road building materials. These are: (1) Eastern Kentucky (the "Mountain"), including the Knobs. (2) Central Northern Kentucky, or the Bluegrass Section. (3) The Mississippian Plateau, or central, southern, and western Kentucky. (4) The Western Coal Field, and (5) The Jackson Purchase. In the description of the road building materials of the State the above order has been followed.

The State system of highways as designated by the State

legislature of 1920-1922 comprises Federal aid roads constructed in part by Federal money and in part by State money usually in equal amounts. State roads are a part of the primary system and may be constructed in part by State funds and in part by county funds that have been turned over directly to the Department of State Roads and Highways. Some counties have donated certain sums of money to the State, and the roads constructed by the aid of these funds may be either Federal or State highways. Over 4,000 miles are included in the State primary system. By this system when completed all county seats within the State will be connected with each other. All other roads where the State does not aid in their construction are designated as county roads, or, as private roads.

Photographic illustrations presented as a part of this report show quarries, crushers, asphalt deposits, gravel beds, good roads and poor roads. In some of the quarries there is a distinct line of demarcation between the stone that meets the State requirements for the construction of permanent roads and the inferior stone that fails to meet requirements. While the photographs indicate in some degree the size of a given quarry, it does not follow that the size of a given quarry is an exact measure of its value as road metal. Much of the stone may have been quarried for building or constructional purposes, or for agricultural lime. It sometimes happens that the best road metal of a given county is represented by only one quarry or a quarry prospect. It does not follow that a quarry having a rock crusher in operation today will be active tomorrow, for many quarries found active last year are idle this year and new quarries have taken their places. This does not imply either that the quarry is exhausted, or the stone inferior. It may be that the stone for the construction of a given piece of road may be obtained more advantageously from another quarry. The questions of the removal of overburden and the length of haulage enter into the problem.

Many of the rock asphalt deposits have proven difficult to photograph and bring out the relations desired in detail. In the case of large fields that have been definitely proven by test pits only there is but little that a photograph can reveal. In the case of the large plants like the one at Kyrock, Ky., in Edmonson County, a good photograph may reveal much of value. A photograph may portray somewhat the size of a given deposit of bank gravel, or the size of the present working face, but the size of the individual pebbles is not revealed unless the actual measurement is known.

The above investigations have led to the conclusion that the road building materials of Kentucky naturally fall into five distinct classes. (1) Limestones, (2) Sandstones, (3) Rock Asphalt, (4) Gravel, (5) Chert and Quartz Boulders. They may also be classified from a different viewpoint. (1) Those well suited for the construction of the base course only. (2) Those well suited for the construction of both the base course and the hard surface. Many of the sandstones fall in the former class but a calcitic sandstone or quartzite may have a sufficient amount of calcium carbonate to serve as a binder and therefore such sandstones could be wisely used in hard surfacing a highway. The second class implies that the limestones are sufficiently resistant to abrasion and contain sufficient binding power for use in both courses.

The gravel may be subdivided into three classes. (1) River gravel, (2) Bank gravel, and (3) Creek gravel. The third class is perhaps best included in the second for it appears to be a modified bank gravel. It is lower in binding power than bank gravel for a part of the clayey matter and the iron oxides have been washed out by the action of the streams. Another classification of gravels is possible. (1) Those well suited for the manufacture of concrete. For this use 25 per cent of the gravel must be retained on a one inch sieve. (2) Those suited for the hard surfacing of highways. Such gravels should be free from large pebbles or boulders. (3) Those deficient in binding power for hard surfacing but which may be used upon the addition of the proper amount and kind of binding material.

It is hoped that the investigation already begun upon the road building materials of Kentucky will be continued until the value of every quarry for road metal is definitely known, new quarry possibilities along proposed highways discovered, new fields of rock asphalt determined and opened up for a larger and cheaper production, and the vast gravel deposits of the State

better understood. This report, therefore, should be considered only as one of progress.

A short bibliography showing some of the more important publications relating to road building materials accompanies this report. No attempt, however, has been made to make this bibliography complete.

CHAPTER II.

CHARACTERISTICS OF ROAD MATERIALS.

Kentucky is exceedingly fortunate in having a great abundance of good road metal. Satisfactory road material is widely distributed throughout the State. Nearly every county within the State has within its boundaries material that can serve for the construction of the major portion of its roads. In many counties, however, additional field work is necessary, and many laboratory tests must be made, to determine the material that is best suited for the construction of a given piece of road. The saving in expense to the State that this natural distribution effects cannot be estimated, but is apparent at the present time. Preceded by detailed investigation of materials it will be possible in the future to build roads more cheaply in Kentucky than in many other states where the greater percentages of materials utilized must be shipped long distances.

It is true that the granites, syenites, diorites, and diabases that are used so extensively in road construction in many states do not occur in Kentucky. The only igneous rocks known to occur in the State at the present time are the basic peridotite dikes of Elliott and Lawrence counties in the eastern part of the State, and in Crittenden, Livingston and Caldwell counties in the western part of the State. These narrow dikes cannot be considered as commercial road building material for in most instances they are thoroughly decayed by weathering processes.

The road materials of Kentucky consist of limestones, sandstones, rock asphalt, gravel, chert and quartz boulders. There is a wide variation in the quality of these materials. Some limestones and many sandstones are absolutely unfit for road metal. The limestones in some localities are too soft and wear away too rapidly under traffic while the sandstones, like the Peach Orchard sandstone of the Big Sandy Valley, are deficient in bonding material.

Road Building Rocks.

Requisites: There are three well known requisites for road building rocks. (1) A suitable road stone should be soft enough

to grind to dust slowly under the traffic to which it is subjected. (2) The dust should have a high cementing power. (3) The separate fragments of stone should have sufficient strength to resist the crushing action of wheels. Where the traffic is light a hard stone may not furnish enough dust to replace that blown away by the wind, washed away by the water, and to bind the surface. In such a case a softer stone or one with a higher cementing power is preferable.

Trap: This is a popular term applied to any dark colored, massive, igneous rock. The gabbros, diorites, diabases and basalts are included in the term. They are very compact and elastic rocks. They have a high resistance to crushing without being too brittle. Their dust has the cementing power in a high degree. They are not all equally desirable for purposes of road construction, but nearly all of them are better than the best of other rocks. The basic igneous rocks called traps should be placed first in the order of utility among all road building stone. Unfortunately these rocks are all wanting in Kentucky.

Granite: Next in value to the trappean rocks as road metal are those commonly called granites. An essential feature of granite is an evenly granular structure coarse enough to be distinctly visible to the naked eye. Granites vary somewhat in texture for some are coarsely porphyritic while others are very fine grained. They vary also in value. As a rule they are very hard and durable rocks and make a satisfactory road metal. They are considered inferior to the trappean rocks for several reasons. (1) Their coarsely granular texture. (2) The brittleness of the requisite quartz and feldspars. (3) The low cementing power of its dust. If the quartz fails so that the rock may be technically called a syenite it is the best for road metal among the various types of hollocrystalline rocks. A granite abnormally high in quartz content is too brittle for use as a road metal. A granite containing too much of the feldspars is easily decomposed. A granite exceedingly rich in its mica content is too easily split for road work. The gneissoid granites make a very inferior road metal. The granitic rocks are not represented in Kentucky.

Limestones: Limestones are often deficient in hardness and toughness for road metal. They possess cementing power in a

fair degree. The best limestones for road metal require three factors. (1) The layers of limestone should be comparatively thin. (2) There should be little sign of crystallization. (3) They should contain less than 25 per cent of clayey matter. In proportion as limestone assumes the crystalline character of marble its value as a road metal diminishes, for the crystalline structure in most cases so far weakens the mass that it is apt to pass readily into the state of a powder. According to reports compiled by the Massachusetts Highway Commission, 1896-1901, marbles have a high per cent of wear and a low cementing power. The best limestones for road metal are those that are compact, fine grained, and break with a conchoidal or angular fracture.

Kentucky is exceptionally fortunate in possessing a wide distribution of limestones well suited for the construction of permanent highways. This condition will be reflected in the discussion of the road building materals by counties in subsequent portions of this report. The limestone outcrops in Kentucky cover fully three-fourths of the entire State. They are practically absent from the Eastern coal measures, the Western coal measures and the Jackson Purchase. Even in the Eastern coal measures the St. Louis limestone is brought into view by the Pine Mountain fault and made available for road work. In the Western coal field limestones are occasionally encountered. In the Jackson Purchase limestones appear in Calloway County west of the Tennessee River. The Ordovician terranes as represented in central Kentucky, or the Blugrass district, in 39 countis are considered suitable for macadam, provided a proper selection of the stone is made, with the possible exception of the Oregon formation which is a dolomite and which occurs in gorges of the Kentucky River and its main tributaries wherever they trench the Jessamine Dome. The Eden shales carry some limestones and some sandstones, but the entire series is regarded as too thin bedded and friable for road construction. It must not be expected, however, that all outcrops of any given formation will meet the State requirements for road construction.

The Silurian System (Niagaran terranes) forms two distinct belts in the State. The belts are both narrow. The easternmost belt extends in a northeasterly direction from Lincoln County to Mason County on the Ohio River. The westernmost

belt extends in a northerly direction from Larue and Marion counties on the south to Trimble and Carroll counties on the Ohio River. In this series the Louisville limestone which is fine grained, thick bedded and dolomitic, is regarded by the author as the best road metal.

The Devonian System of rocks encircles the Bluegrass region southwesterly from Lewis County on the northeast to Adair County and then northwesterly to Oldham County. Another and much smaller series of outcrops extends in a southwesterly direction from Pulaski County to the Tennessee line. The lower formations which are Middle Devonian contain valuable limestones for road construction. This is well illustrated in some of the quarries around east Louisville. The Upper Devonian is essentially shale which is regarded as too soft and friable for road metal although in Rowan County the Chattanooga shale has been used in grading and in the base course.

The Mississippian System of terranes encircles the combined Ordovician, Silurian and Devonian formations from Lewis County on the northeast to Jefferson County on the northwest. Both of these counties are on the Ohio River. The Mississippian System also encircles the western coal field and finds its western termination in Livingston County on the Ohio River.

Sandstone: Sandstones are deficient as road metal for two reasons. (1) They are easily reduced to sand. (2) They are deficient in binding power. They are, however, often highly resistant to abrasion and impact. In some instances sandstones have sufficient binding material between the individual sand grains to hold the mass firmly together in such a manner as to render them fair road metal. In a calcitic sandstone or quartzite like the one found on the Mayo trail in Johnson County with a coefficient of wear of only 2.0 the lime should furnish binding material as rapidly as the stone is worn to dust. This sandstone will stand up under a roller.

The chief difficulty with standstones for macadam construction is that they are often almost wholly devoid of cementing properties and therefore grind up under traffic into a mass of loose sand. Such a sandstone is represented by the yellowish white Peach Orchard sandstone of the eastern coal field.

Sandstone paving blocks are preferred by many engineers

to the granite paving blocks, for five reasons. (1) They are easily worked. (2) They are sufficiently abundant. (3) They are widely distributed. (4) They are resistant to abrasion. (5) They do not wear slippery like many granites. Their rapidity of wear is about the same as that of the cement mortar used as a filler. In the case of the granite the mortar wears away more rapidly than the granite paving blocks, therefore they wear smooth and rounding.

Several of the sandstones of Kentucky are sufficiently resistant to abrasion to serve as the base coarse in the construction of permanent highways. This holds especially true of the bluish gray, neutral gray, and drab sandstone of the Pennsylvanian coal measures in the eastern part of the State. These sandstones are also utilized as the coarse aggregate in concrete for bridge construction and the paving of streets.

Quartzites are sparingly present in Kentucky. They may appear in fault zones as at the locality 3 miles south of Smithland in Livingston County, and locally in the more highly metamorphosed phases of the sandstones in the eastern part of the State. It may be found difficult to hold these quartzites together either with a clay binder or limestone screenings. They will however make a satisfactory road if used either as the coarse aggregate in concrete or with a bituminous binder.

Most of the sandstones of Kentucky belong to the Pennsylvanian System. They cover at least one-fourth of the area of the entire State. They represent two large fields. (1) The Eastern coal measures. (2) The Western coal field.

Chert: This is a variety of quartz that breaks with a splintery fracture rather than conchoidal. It will usually give fairly good results as a road metal. It is of great value when it occurs in abundance in those portions of the State where good road building materials are scarce or entirely wanting. This condition is well illustrated by the Jackson Purchase where practically the sole source of road building material is a cherty gravel.

Shale: A shale is a consolidated mud or clay in which the silicates of aluminum are the most important constituents. In texture it is fine grained. In structure it is laminated or fissile. For engineering purposes when the indurated clay is nearly pure it is termed an argillaceous or clay shale. When it con-

tains a considerable amount of sand it is termed an arenaceous or sandy shale. For road building purposes the argillaceous shales are worthless and the arenaceous shales are useful only for a top dressing. They are not satisfactory even for that purpose.

Shales are represented in Kentucky associated with the various limestone and sandstone formations. The most conspicuous formation is the Ohio shale of Miller, or the Chattanooga shale of Hayes. The black color is due to organic matter. Its oil content approaches four or five per cent. It is often called a black slate but it does not possess the characteristic ring of slate when struck with a hammer. In its chief outcrop it surrounds the Bluegrass district, a little outside the Silurian-Devonian outcrops.

Slate: As a road metal slates quickly grind to a dust that has but little binding power. Slate makes a smooth road, but one that wears away rapidly when wet. It is sometimes used as a surfacing or binding material, but it is much inferior to clean sand or good stone dust. True slates do not occur in Kentucky.

Field Stone: In many glaciated districts an excellent road material may be obtained by crushing the various boulders and pebbles that are too coarse for use in gravel roads. In New England the complex mixture of the basic and acidic intrusives with the metamorphosed sedimentaries has produced a very satisfactory permanent road metal. Wherever glacial boulders are badly decomposed they are essentially unfit for road building purposes.

Only a small portion of Kentucky suffered glaciation during the glacial period. This narrow belt, varying from three to ten miles in width occurs in Campbell, Kenton, Boone, Gallatin, Carroll and Trimble counties. The deposits are unstratified till with boulders and upland loess. The outwash of these glacial deposits extends in a southwesterly direction to Jefferson County where the deposits consist of coarse gravel followed by sand and silt.

Gravel: Gravel to meet the essential requirements of road metal must consist of hard and tough pebbles for three reasons. (1) A gravel macadam is subject to impact which tends to break and displace the constituents. (2) It is subject to abrasion by the shearing of the driving wheels of motor cars and the slipping or skidding of the wheels. (3) It is subject to deterioration by climatic agencies which tend to blow, or wash, the fine cementing materials away or weaken the road bed.

Gravels should be carefully graded according to various sizes so as to give the maximum degree of compactness and density. Gravels should contain a sufficient amount of binding material to cement the pebbles together and yield a minimum of displacement. The best cements in gravel are: (1) Clayey matter. (2) Hydrous oxides of iron. (3) Calcium carbonate. Two or all of these cements may be found in the same gravel deposits. The first two of these cements are found in some of the gravels of the Jackson Purchase. The last one is especially abundant in the glacial gravels of eastern Vermont. If a gravel pit 15 or 20 feet in depth will maintain a vertical face, it suggests that the gravel deposit has in it sufficient bonding material to make a satisfactory road metal. In selecting a gravel for road work a petrological study of the pebbles composing the gravel is important. The acidic and basic igneous rocks, quartzites and other siliceous rocks, and even fine grained, compact limestones, when unweathered are usually resistant, tough and give life to a road. A gravel made up of soft sandstone, or soft limestone, or shale, or slate, is usually of little value in road construction.

The State of Kentucky is especially fortunate in possessing a great abundance of River gravel in the Ohio River, and near the mouth of the Cumberland and Tennessee rivers. Some of the smaller inland rivers carry good gravel deposits. Practically inexhaustible bank gravels occur in the Jackson Purchase and between the Cumberland and Tennessee rivers. Inland scattered areas of gravel also occur.

Rock Asphalt: Rock asphalt consists of either sondstones or limestones the interstices of which are filled with bituminous matter, which is sometimes, but not always, asphalt. Asphalt, or asphaltum, is a term often applied to the mineralloids albertite, jilsonite, grahamite, uintaite, etc. It is black or brownish black in color, brittle, and breaks with a deep conchoidal fracture. It is often derived from the distillation of petroleum having an asphalt base.

The Kentucky rock asphalt is simply a sandstone impregnated more or less with a thick tarry oil. The rock asphalt de-

posits of Kentucky are recognized as old oil sands. The thickening of the oil content is due to the evaporation of the more volatile constituents and the oxidation of the residue by reason of its being brought near the surface through the carrying away of the overlying surface during the process of erosion.

The asphalt deposits of Kentucky occupy two distinct fields. One is found in the northeastern part of the State at Soldier in Rowan County. The other is in the western part of the State extending in a somewhat broken line in a southwesterly direction from Breckinridge County on the north through Grayson, Edmonson, Warren and Logan counties. These asphalt deposits are found in rocks of both Mississippian and Pennsylvanian age.

Rock asphalt if sufficiently rich in its bitumen content makes a very satisfactory material for surfacing streets and highways. It requires but little treatment other than crushing and uniformly mixing before it is spread over the surface of the road and rolled. Many northern cities contain streets that were surfaced with asphalt more than a century ago. The asphalt has proved a highly satisfactory road metal. Asphalt is also used in the construction of sidewalks.

CHAPTER III.

TESTS OF ROAD BUILDING MATERIALS.

Laboratory tests are made upon road building materials in order that the relative value of particular rocks, gravels and rock asphalts may be definitely known. To be of value these tests must be expressed numerically. Laboratory tests are useful and significant, but they are not entirely satisfactory. They must be interpreted with sound judgment. They not only reveal the character of the rocks that meet all of the State requirements for road metal but they also show the chief characteristics of rocks that fail to pass some of the requirements, and thereby show the safest material to use in sections where road metal meeting all requirements can be secured only by long haulage and great expense. It must be remembered, however, that the most satisfactory tests that can possibly be applied to road building material is its actual use in the roads under proper construction.

In the laboratory an effort is made to reproduce the destructive agencies to which a road is subjected. The hardness of a stone is tested to ascertain its resistance to abrasion. Stones in the road are rubbed against each other by the action of traffic. The toughness test is taken to show the power of the stone to withstand blows without fracturing. These arise from the pounding of the feet of horses, and from car wheels where inequalities of wearing surface exists. The cementing test is designed to show as nearly as possible the rapidity with which the dust produced by traffic will bond the coarser material.

In collecting samples for laboratory tests a difficulty is encountered in securing a sample that represents the entire quarry. Surface samples easily collected are too often sent into the laboratory. These weathered samples give erroneous values for the entire quarry. If there are five or more different types of limestone in a given quarry either each type should be sampled separately or each type should be represented in a single sample in approximately equal amounts. It often happens in Kentucky that the upper beds of limestone in a given quarry are too soft to meet the State requirements while the lower beds are very sat-

isfactory road building material. The reverse of this condition may also exist. In either case the softer material should be rejected. It also happens that the material in one end of a quarry will meet State requirements while that in the other extremity of the quarry will fail to pass the rqeuirements. In sandstone quarries where the various layers are intercalated with thin layers of shale the introduction of the shale which should be rejected in road construction will cause the sample to fail in laboratory tests. The sample should also be collected free from any of the adhering overburden of soil.

The samples collected during the summer of 1923 and sent to the State testing laboratory at Lexington, Ky., contained one or more pieces that were 6 inches in length, 4 inches in width and 3 to 4 inches in thickness with the smaller fragments exceeding 2 inches in diameter. The entire sample weighed not less than 40 pounds. The entire sample may be a single block weighing not less than 40 pounds, but three or four large pieces from different portions of the quarry would give more satisfactory results. All samples sent to the State laboratory should be sent by express prepaid with a careful legend of the exact quarry or location from which the sample was taken. It may be of interest to some of the readers of this report to know that the Office of Public Roads, Washington, D. C., tests material for road construction free of charge, provided the samples collected are of proper size and shipped by freight or express prepaid.

Stone.

The selection of material for road construction so that the surface of the road when completed will be exactly fitted to the traffic on that particular road is a very important factor. Some of the softer limestones that might make a fairly satisfactory road for light traffic are totally unfit for the construction of roads subjected to heavy traffic. Under the latter condition the road will ravel and wear away too rapidly. The ideal road building stone is one from which just sufficient fine material will be worn off by traffic to keep the larger fragments cemented together. If a stone that never has been tested in the laboratory has been used locally and given good satisfaction it is reasonably safe to assume that the same stone under proper methods of construction

may be used again with safety. Many quarries within the State that have failed to satisfy State requirements, might be resampled using correct methods of sampling and found to pass. Unsampled quarries should be properly sampled. The results of such sampling could be placed by hachure upon a quarry map and thus represent every known quarry within the State. The engineer then in bidding upon a contract would know exactly what material is available for road construction. The saving of moneys to the State resulting from such work would be large.

Specific Gravity: The specific gravity is the weight of a given volume of the stone compared with the weight of an equal volume of water. A small fragment of the stone is first weighed in air in the upper scale pan and then transferred to the lower scale pan and weighed in water. The weight in water is subtracted from the weight in air and the weight in air is divided by the factor obtained. Let W = weight in air. W′ = weight in water. Then the specific gravity $= \frac{W}{W - W'}$

The displacement method is often substituted for above method. A sample of 20 to 25 grams is carefully weighed and the weight recorded. Then a beaker is weighed and its weight is recorded. A can with side delivery tube is filled with water and the sample weighed in air is immersed in the water. The beaker and the water displaced are then weighed and the weight recorded.

Let W = weight of stone and W′ = the weight of water displaced. Then specific gravity $= \frac{W}{W'}$

Limestones suitable for road building material usually fall between 2.60 and 2.77 in specific gravity. If they fall below 2.60 they are apt to be too porous or too badly weathered to prove satisfactory.

Weight Per Cubic Foot: To ascertain the weight per cubic foot of a given stone the specific gravity of the stone is multiplied by the weight of a cubic foot of water which is often taken as 62.5. Thus if the specific gravity of a given stone is 2.65, then the weight of a cubic foot of that same stone would be 165.6 pounds. However it must be borne in mind that this is not the

weight of a cubic foot of crushed stone but that of a solid cube each face of which is one foot in length, or height, or breadth. A cubic foot of crushed stone would be somewhat lighter.

Absorption: This test refers to the number of parts of water that will be absorbed by a given stone within a given period of time. This period of time ranges from one to four days according to the custom of the laboratory in which the test is made.

The same specimen that is used to determine the specific gravity is used to determine the ratio of absorption. After the specimen has been used to determine the specific gravity it is allowed to stay in water for 24 hours (Lexington laboratory). The water enters the interstices among the mineral grains and replaces the air. Its weight is then recorded and the ratio computed.

To ascertain the number of pounds of water which a cubic foot of rock will absorb in four days the following formula is often used:

Let W = Weight in air.

W′ = Weight in water.

W″ = Weight in water after 4 days.

Then absorption in pounds per cubic foot will equal

$$\frac{W'' - W' \times 62.37}{W - W'}$$

The absorption test gives a second method of telling whether a stone is dense, compact, or porous. The author has in his private laboratory a sample of calcitic sandstone, 5 inches in length, 1½ inches in both breadth and thickness, that will absorb in one hour one-half its volume of water. This illustrates an extreme phase of porosity. When porous rocks are saturated with water and the temperature falls below freezing so that the water solidifies throughout the sample the expansive force is equal to the weight of a column of ice one mile high. Porous rocks are therefore more apt to be broken when the temperature falls below freezing than hard and compact rocks. Highways therefore built of porous rocks wear away more rapidly than they would if constructed with hard dense road building stone. It is claimed by some authors that there is an advantage in having somewhat porous rocks to use with a bituminous binder, but

this experimental type of road has not yet been tried out in Kentucky, and its value is not known.

Per Cent of Wear: This is one of the oldest tests of road material and is regarded as one of the most successful tests. It was devised by a French engineer named Deval. In the Lexington laboratory a cylinder 34 centimeters in length and 20 centimeters in diameter is used. Each cylinder has an axis inclined about 30 degrees to the axis on which it turns. 5000 grams of stone broken into fragments that will pass a 2 inch screen and be retained on a 1½ inch screen are used. After the material has been placed in the cylinder it is given 10,000 revolutions at the rate of 30 to the minute. In each revolution the small fragments of stone fall against each other and from one end of the cylinder to the other. The amount of material worn off from the stone that will pass a 1/16 inch sieve is determined. Thus, if the percentage of wear is recorded as 2.0, as in the case of a calcitic sandstone from Johnson County, it means that 2 per cent of the material tested was ground sufficiently fine to pass through a 16 mesh sieve. If in this test the Deval machine is allowed to make more than its 10,000 revolutions the percentage of wear will be correspondingly higher.

In some laboratories 50 pieces of stone that will pass a 3 inch ring and be held on a 1½ inch ring are selected for this test. They are so selected that their total weight is approximately 10 pounds. In other respects the test is identical with that used at Lexington.

French Coefficient of Wear: The formula in general use to determine the French coefficient of wear is

$$\text{French coefficient} = \frac{40}{\text{Per cent of wear}}$$

If the per cent of wear in a calcitic sandstone is 2.0 as in the case of the sample cited from the Big Sandy Valley, its French coefficient would be determined by dividing 40 by 2.0 which equals 20. 8 is considered low, 9 to 13 medium, 14 to 20 high, and above 20 very high. In the softer rocks the percentage of wear is expressed by the higher figures. In the French coefficient the more durable rocks are reflected by the higher numbers.

Hardness: This test is designed to show the ability of a

rock to resist frictional wear. In the test as carried out in the State testing laboratory at Lexington a cylinder 1 inch in diameter is cut out with a core drill. It is then held against a flat revolving disc under constant pressure of 1250 grams. Sand is fed on the disc to aid in wearing away the rock. The disc runs for 2,000 revolutions. The grinding is all done on the same end of the sample. The interpretation of the test is made from the amount of material that is worn away. The numerical result is obtained by subtracting one-third the loss in weight in grams from 20. A hardness expressed as 14 means that 3 times the difference between 14 and 20 was worn off the specimen in 2,000 revolutions, or 18 grams was the loss in wear. The test as carried out in some laboratories has 1,000 revolutions of the disc wearing away one end of the specimen and then the specimen is reversed and 1,000 revolutions applied to the opposite extremity. In test cylinders whose extremities vary widely in hardness this reversal may have an advantage. Below 14 is considered soft, from 14 to 17, medium, above 17, hard.

Toughness: The toughness test is designed to show the power of a rock to resist fracture when subjected to blows. A cylinder of rock 1 inch in diameter is put in a machine suggesting a small pile driver. A hammer is dropped upon the test specimen from constantly increasing heights. The increment of increase in distance is 1 centimeter. The number of blows required to break the specimen indicates the toughness and is expressed as the coefficient of toughness. A coefficient of 10 indicates that the specimen fractured with 10 blows. Below 13 is considered low, 13 to 19, medium, and above 19, high. Test specimens breaking with less than 9 blows are recorded as failing.

Cementing Value: This test is not usually made in the State testing laboratory at Lexington, Ky. It may, however, be made at any time when deemed advisable. In making this test the material is ground in a ball mill with sufficient water to make a stiff paste. The grinding continues for 2½ hours at the rate of 2,000 revolutions per hour or a total of 5,000 revolutions. The paste is then made into cylindrical test blocks 1 inch diameter and 1 inch in height in a special machine which gives the same amount of pressure to each briquette. The testing machine drops a hammer on the top of the briquette. The number of blows required to destroy the specimen is taken directly as giving the cementing value of the stone tested. Below 10 the cementing value is regarded as low, from 10 to 25, fair, from 25 to 75, good, above 75, very good.

Fitness: The conclusions regarding fitness are drawn from the results of the foregoing experiments. They may be expressed as: Meets all of the State requirements, very good; or passes the State requirements for base course, rubble masonry, and the coarse aggregate in concrete; or failed to pass State requirements.

Weight Per Cubic Yard: The weight of a cubic yard of road building stone varies widely. It depends largely upon four factors. (1) The specific gravity of the rock itself, for it is obvious that the higher the specific gravity of the rock the more a cubic yard of the stone will weigh. (2) The size of the individual fragments for the smaller subdivisions of the stone, the closer it packs, so that screenings weigh more per cubic yard than stone designed for the coarse aggregate in concrete. (3) The method of loading, for when stone is dropped into a hauling truck from a high loading chute it will be more compact than if dropped only a short distance. A cubic yard will therefore weigh more. (4) The distance the rock is hauled, for the crushed stone settles materially during long haulages, and a cubic yard when first loaded is less than a cubic yard when it reaches its destination. It is obvious therefore that a cubic yard of stone does not signify a definite weight.

The Illinois Highway Commission adopted 2,500 pounds as the standard weight of a cubic yard of crushed stone. This weight is greater than the average weight of a cubic yard of 1½ inch to 3 inch stone and less than the average weight of a cubic yard of screenings.

Gravel.

It is often stated that there are no satisfactory tests for gravel to determine its suitability for road construction. Certain tests however can reveal certain properties that the engineer should know. The petrological examination has already been cited in Chapter III.

Hardness Test: This test consists of taking at random 100 pebbles from a 30 pound sample of gravel and trying to scratch each pebble with a manganese file. Pebbles may be considered as soft when easily scratched with the file, and as hard when faintly marked with the file. The ratio of soft to hard pebbles is thus determined. This test can be applied in the field examination as well as in the laboratory. It should always be followed by the abrasion test.

Abrasion Test: The gravel is first screened through screens having circular openings 2 inches, 1 inch, and ½ inch in diameter. The sizes used for this test are equally divided between those passing the two inch and retained on the one inch screen, and those passing the 1 inch and retained on the ½ inch screen. The material retained for the test is all washed and dried. 2,500 grams of each of the two sizes selected are taken for the test. The material is placed in a cast iron cylinder of the Deval machine and given 10,000 revolutions at the rate of 30 per minute. At the completion of the 10,000 revolutions the material is removed from the cylinder and screened through a 11/16 inch sieve. The remaining pebbles are washed, dried, weighed, and the percentage lost by abrasion that will pass a 1/16 inch sieve definitely calculated.

Mechanical Analysis: The following mechanical analysis limits have been recommended by the United States Office of Public Roads and Rural Engineering, Washington, D. C., for use in the base course of gravel roads:

1. All to pass a 2½ inch screen and to have at least 55 and not more than 75 per cent retained on a ¼ inch screen.
2. At least 25 and not more than 75 per cent of the total coarse aggregate to be retained on a 1 inch screen.
3. At least 65 and not more than 85 per cent of the total fine aggregate to be retained on a 200 mesh sieve.

The mixture as above given has a maximum of stability under the weight of traffic.

Cementation Test: In making this test 500 grams are taken and placed in a ball mill with 90 cubic centimeters of water and 3 steel shot, each weighing 16¾ pounds. The sample is ground for 6,000 revolutions until a stiff paste is made. The paste is then taken from the ball mill and fashioned into briquettes under

a pressure of 1,877 pounds per square inch. 5 briquettes are made of each sample of gravel tested. These are allowed to dry in the air for 24 hours. They are then placed in an oven maintained at a temperature of approximately 200 degrees Fahrenheit for 4 hours. They are then removed, dessicated, and tested in a small Page impact machine. The number of blows required to break a cylinder is taken as the comparative binding power of the material used.

Tenacity Test of Binder: This test is made to determine the coherency of the binding portion of the gravel. The materials selected must pass a 10 mesh sieve without grinding. A stiff paste is made of the material passing a 10 mesh sieve and molded into cylinders approximately 1 inch by 1 inch. These cylinders are thoroughly dried at a temperature of about 200 degrees Fahrenheit and broken with the small Page impact machine. The number of blows required to break a cylinder is taken as expressing its tenacity.

Gravels containing pebbles exceeding 2 inches in diameter should be screened to remove all pebbles that are over size. Such pebbles will not pack on a gravel road. If the gravel contains an excess of sand it should also be screened for it is difficult to pack a gravel containing an excess of sand when that sand is very fine.

Rock Asphalt.

Rock asphalt is not a product of uniform composition, nor is it of uniform texture. The bituminous material coats the individual sand grains and sometimes the bitumen content is so high that the voids in the stone are completely filled. In general the percentage of bituminous material in commercial rock asphalt runs between 6 and 8 per cent of the mass of the rock. It is sometimes lower than the per cent given and such deposits failing to meet State requirements are regarded as "lean." The bituminous content may be much higher than the figures given as in the especial sample from Grayson County, Kentucky, which gave in analysis 77 per cent volatile matter. The character of the bituminous material also varies. In some deposits a light oil may be present and in others a heavy oil.

The character of the sand grains also varies. The sands may be very fine and water-worn as in Breckinridge County, Kentucky. They may be medium in size as in Edmonson County, or they may be coarse and angular.

Kentucky rock asphalt has been widely used in the construction of dustless roads. A test road was made by the United States Office of Public Roads in 1907 in Bowling Green, Kentucky. This road was inspected in December, 1910, and found to be in good condition. The cross section was well maintained. The surface rang sharply under the blows of horses hoofs. The stone was thoroughly bonded and showed no signs of raveling. A small specimen of the asphalt when dug up and warmed in the hand showed that the bitumen still had considerable life.

Bitumen Test: Five samples are taken from different parts of the sample submitted. The material selected is thoroughly mixed. A test sample of 5 grams is taken and the bitumen, and other volatile matter present, is removed by the ignition test. The remaining silica sand is dessicated and weighed. The loss represents the moisture that would be expelled at 105 degrees C., the bitumen, and any other volatile matter that may be present. The total loss divided by five will represent the per cent of bitumen, moisture and other volatile matter if present. The actual bitumen content is determined by the amount of volatile matter that is soluble in benzol. A sample of rock asphalt from Cloverport, Breckinridge County, Ky., collected August 29, 1923, and submitted to the State testing laboratory, Lexington, Ky., gave the following results:

That part from the center had loss on ignition of	6.19%
That part from the center soluble in benzol	4.48%
That part from the outside had loss on ignition of	7.34%
That part from the outside soluble in benzol	4.69%

This material does not pass under State specifications. It contained other volatile matter than bitumen. The total amount of volatile matter other than bitumen is found by subtracting the amount soluble in benzol from the total amount lost by ignition.

Some chemists in making an anlysis of rock asphalt determine the amount of moisture that is expelled at 105 degrees C., and then the amount of combustible matter present. The per cent of residue represents the silica sand. The actual per cent of bituminous matter present is determined by the amount soluble in carbon disulfide.

CHAPTER IV.

ROADS AND THEIR REQUISITES.

Good roads are both an economic and a moral necessity. The people in the city must have food in order to subsist. They must have roads or streets in the city to facilitate business transactions. They are also a necessity for the normal pleasures of city life. Good roads are demanded in the country that the boys and the girls who stay on the farm may market their products or transport them to rail. In many localities without roads that lend themselves to enjoyment and the marketing of products the boys and girls are leaving the farms and seeking the cities. The intellectual development of our rural communities demands good roads that the children may reach rural schools. Many states have been slow to grasp the necessity of permanent roads that now are expending millions annually in their construction and maintenance. The automobile industry has become gigantic. It demands good roads and is willing in a large measure to pay for them.

Definitions: The avenues of travel by humanity so often called roads have been variously designated. The interpretations applied to them have been variously interpreted. A series of standard definitions have crept into engineering literature. To avoid confusion it seems wise to repeat them here.

1. Highways are the right of ways devoted to public travel.
2. Roads are highways outside of a city, town, or village.
3. Streets are highways within a city, town or village.
4. Boulevards are wide roads or streets aesthetic in their effect.

Pavements are the surfacings of carriageways, footways monolithic in type with a cement or bituminous binder, or composed of blocks.

Classification: Roads may be classified according to the character of their wearing surface.

1. Waterbound macadam in which the wearing surface consists of broken limestone or broken slag.
2. Bituminous macadam. The bituminous macadam sur-

face is laid on a reconstructed broken stone, or broken slag base course, or on a broken stone or slag base course. The surface course is composed of broken stone and a bituminous binder applied by the penetration method, with a bituminous seal coat covered with stone chips or torpedo gravel.

3. Bituminous concrete surface. The surface of this course consists of a mineral aggregate composed of coarse aggregate, fine aggregate and mineral filler uniformly mixed with bituminous cement laid upon the prepared base. A seal coat of hot bituminous cement is then applied and covered with intermediate aggregate.

4. Bituminous concrete—Bitulithic type. This pavement consists of a bituminous wearing course made from the compacted mixture of mineral aggregate and bituminous cement.

5. River gravel surface. The wearing surface consists of river gravel laid to conform to the cross sections and number of courses suggested in the specifications for the road.

6. Unrolled creek or bank gravel surface. The wearing surface consists of creek or bank gravel laid to conform to the cross sections and number of courses shown in the specifications.

7. Rock asphalt surface. This surface consists of a compacted layer of rock asphalt laid on a base course of either cement concrete, broken stone, broken slag, gravel, or asphaltic macadam.

There are several modifications possible of these main types.

Investigations: Before a road is definitely located like the Mayo Trail in the Big Sandy Valley in Eastern Kentucky, a preliminary investigation should be made to determine the following factors:

1. Best location.
2. Drainage.
3. Foundation.
4. Width most advantageous.
5. Aesthetics.
6. Traffic census.
7. Speed of various classes of traffic.
8. The climatic conditions.
9. The topographical features.
10. The geological features.

11. The availability of hard rocks for base course.
12. The proximity of surfacing materials.
13. The character and price of available labor.

Location: A road may be located in a given section most advantageously for several reasons.

1. The shortening of distance between important cities, villages, or county seats.
2. To avoid heavy expense in cliff cutting.
3. To avoid heavy expense in grading.
4. To avoid ponds and swamps.
5. To reduce the number of necessary bridges to a minimum.
6. The proximity of good road building materials.
7. For aesthetic reasons.

Drainage: Water is a destructive agent in the construction and maintenance of highways. Roads should be so constructed that water will not stand either upon the surface or at the sides of highways. It is often an active agent of destruction when brought up to the surface of the road by capillarity. Such a road soon pits. A sand or gravel soil favors a good subdrainage but a clayey or plastic soil like that in the Jackson Purchase demands very careful attention for soil thoroughly saturated with water has no supporting power. The crown of the road should be so constructed that all of the water falling upon it will be removed to the ditches from which it should escape by catch basins, culverts, and waterways.

Foundations: The average good road in Kentucky represents three stages of construction.

1. The subgrade or the natural foundation.
2. The artificial foundation.
3. The wearing surface.

The type of soil encountered in the construction of the subgrade will be determined largely by the character of the rocks from which the soil has been derived. Soil is usually of mineral composition and is formed by the decomposition of rock masses through the action of corrosive agents in the atmosphere, wind, water, variations in temperature, and vegetation. The soils represent the impurities or insoluble constituents in the rocks from which they were derived. These decomposi-

tion products may be classified as: (1) Gravel. (2) Sand. (3) Clayey matter. (4) Loam. (5) Marl. (6) Peat. (7) Humus. The first five are inorganic materials. The last two are organic.

Gravels consist of fragments of rock that have been worn fairly smooth either by the action of water or the transporting power of glaciers. Most of the gravels of Kentucky belong to the former class for the area in Kentucky traversed by the glacier comprises only a narrow belt in Campbell, Kenton, Boone, Gallatin, Carroll and Trimble counties. In size gravel varies widely, but in good gravel all the pebbles should be retained on a ¼ inch screen, and no pebbles should fail to pass a 2 inch screen. Larger aggregates are classified as rubble. In composition they represent: (1) The calcareous residues of limestones and marbles. (2) The siliceous residues of sandstones and quartzites. (3) Broken fragments of both the acidic and basic igneous rocks. (4) Less frequently broken fragments of shale and slate. Products of the last class are unsuited for road construction.

Sands may be derived as follows: (1) From the decomposition of sandstones and quartzites. (2) From the residues of siliceous limestones. (3) From the disintegration of granites and related rocks. Class 3 is not represented in Kentucky. In good sand no particles should be retained on a 4 mesh sieve.

Clays result in several different ways. (1) From the decomposition of argillaceous limestones. (2) From the decomposition of argillaceous sandstones. (3) From the decomposition of arenaceous shales. (4) From the kaolinization of the feldspathic content of igneous rocks.

Marls are often calcareous clays with a calcium carbonate content not less than 15 per cent. In the northern states the term marl is applied to the calcareous remains of fresh water organisms, and such marl may contain but little if any clayey matter.

Peat is of organic origin. It represents the soil that is derived from the decomposition of vegetable matter under water. Sphagnum moss is the largest contributor to peat in America.

Humus is the soil derived from the decomposition of vegetable matter in contact with air.

Artificial Courses: These courses may be constructed of

(1) Large stone. (2) Broken stone. (3) Hydraulic cement. (4) Bituminous concrete.

Telford: Large stone blocks are seldom used today save in swampy areas where broken stone would be pushed into the soft soil. For a Telford foundation the stone should be sound, tough, durable, with a per cent of wear not exceeding 8. The dimensions should be from 6 to 12 inches in length, 3 to 6 inches in width, and 6 to 8 inches in depth.

Broken Stone: Broken stone is used for the foundation of the upper or wearing course. This is especially true when a macadam road is built with two courses. Stone used for this work should be fine to medium grained, dense, break with an angular fracture and show a percentage of wear of not more than 6.5, and also a toughness of not less than 9.

It is obvious that a course of broken stone compacted to 6 inches will sustain heavier traffic, wear longer and better than one compacted to 4 inches in thickness. It costs more but the better service pays for the extra cost.

Substitutions for broken stone are often made as: (1) Where the haulage of the quarry product would be long. (2) Where the local limestones and sandstones fail to meet the State requirements. (3) Where there are no rocks igneous or sedimentary in origin available for the work. Such substitutions are found in the slags from Ashland, Kentucky, and Ironton, Ohio. These are extensively used in the eastern part of the State. Gravels have been substituted along the Ohio River and in the Jackson Purchase. Cinders and brick-bats may also be used.

Concrete Foundation: Concrete is a mixture of cement, sand, broken stone or gravel. The proportions of concrete should be so adjusted that the voids in the sand will be filled with cement paste, and the sands in the broken stone or gravel will be filled with cement mortar. If more cement or mortar is used than is required to fill all the voids, the cost is needlessly great. The cement is usually the weakest constituent. If more cement is used than is necessary the strength of the concrete is correspondingly decreased. In a perfect concrete every grain of sand will be coated with cement paste, and every point of each fragment of broken stone will be covered with cement mortar.

A good concrete will outlast any surface that may be built upon it.

The advantages of concrete are: (1) It gives a smooth uniform surface upon which to lay the wearing course. (2) It prevents the surface water from percolating to the subgrade. (3) By its thickness and resistance to flexure, it distributes the concentrated load over a considerable area of the subgrade. (4) Being impervious to water and a nonconductor of heat, concrete protects water and gas pipes from freezing. (5) Concrete acts as a bridge to support the pavement in case of a settling of the subgrade.

Bituminous Concrete: Broken stone or gravel thoroughly mixed with asphalt is sometimes used for the foundation course. It has two advantages. (1) It is weaker than a concrete foundation. (2) The highway cannot be repaired without disturbing the foundation.

Wearing Surface.

There are many different types of wearing surface represented in the roads of Kentucky, and the materials that enter into their construction are widely varied. The materials are selected for one or more of the following reasons:

(1) Their resistance to abrasion.
(2) Their binding or cementing power.
(3) Their original cost at point of consumption.
(4) Their cost of maintenance.
(5) Their aesthetic value.

Sand Roads: Sand alone makes a very unsatisfactory road. Fair sized loads may be hauled over such a road when the sand is thoroughly saturated with water, but when the sand is dry travel is extremely difficult. A heavy top dressing of plastic clay was used on a sand road in Norwich, Vermont, in 1896. The road soon became deeply pitted and haulage was more difficult than before. Finally the sand and clay were intimately mixed in the proper proportions and a fairly satisfactory road was the result.

Clay Roads: Clay roads are just as objectionable as sand roads. In dry weather, if properly crowned and scraped, they present a smooth hard surface. The Jackson Purchase and

many other of the less populated sections of the State, are replete with illustrations of clay roads that are deeply pitted and rutted after a heavy rain. The ruts appear like deep wavy furrows. In the spring of the year when frost is leaving the ground such roads contain many deep slough holes.

Sand Clay Roads: It sometimes happens that nature has provided along the route of a proposed highway the proper admixture of sand and clay for a permanent road. It may be that the material available is gravel and clay. If so, then no pebbles more than 2 inches in diameter should be allowed to remain on the surface of the road, and the pebbles themselves should be resistant to abrasion. Fine sand should be eliminated for it is unsatifactory. The typical mass should contain 50 per cent of coarse sand and gravel and 50 per cent of clayey matter. The whole should be uniformly mixed. When sand and clay do not occur along a proposed highway already in proper percentages for road construction, it is possible to mix them in correct proportions.

Wherever sand beds occur suitable for road construction with clay, the clay selected should have the following requisites: (1) It should slake easily enough to enable it to be broken up readily. (2) It should be plastic enough to cement all the sand grains together. (3) It should form with the sand a smooth and impervious surface.

There are four general ways in which sand clay roads may be constructed: (1) Ready mixed sand and clay placed on clay, sand, or ordinary foundation. (2) Sand and clay placed on soil foundation and mixed. (3) Clay hauled on a sand foundation and mixed with the sand. (4) Sand hauled on a clay foundation and mixed with the clay.

If an excess of clay is used in the mixture, the grains of sand which are not in contact are free to move among and upon each other and the resistance of the wearing surface to pressure is low. If an insufficient amount of clay is used the mixture will lack binding power and the wearing surface will soon disintegrate.

Maintenance: The maintenance of an earth road is practically inexpensive. Four requisites are involved: (1) Keeping the surface smooth. (2) Keeping the surface well crowned so

that it will shed water as rapidly as possible. (3) Keeping the ditches and culverts clean so as to provide an outlet for water. (4) Keeping the grass and bushes cut along the highway for earth roads require sunshine and plenty of air.

The first point enumerated under maintenance is of vital importance, for if a pit once starts in the surface of the road, it favors the accumulation of moisture which softens the road and the depression rapidly becomes larger.

When such a pit is filled it should be filled with the same type of material as that used in the construction of the road, so that the road may wear smooth.

Gravel Roads: Gravel to be used in the construction of permanent roads should meet the following requirements: (1) It should be composed of hard pebbles that will not readily pulverize under traffic. (2) The pebbles should vary in size proportionally so that the voids may be reduced to a minimum. (3) It should contain enough bonding material to fill all the remaining voids and cement perfectly the whole body together.

The common cementing materials in gravel are: (1) Clayey matter. (2) Iron oxides and hydrous oxides. (3) Calcium carbonate. (4) Silica in a fine state of subdivision. (5) Loam, which is a mixture of sand and clayey matter.

The Peekskill, N. Y., gravels carry clayey matter as the bonding material. The Jackson Purchase gravels carry the hydrous oxides of iron as well as clayey matter. Sometimes the iron is in excess of the clay. The glaicial gravels of eastern Vermont carry calcium carbonate.

Bank gravels usually carry more of the finely divided mineral grains than river gravels because the action of running water carries away much of the bonding material.

River gravels are therefore usually richer in silica than bank gravels. An excess of clayey matter in any gravel will produce a mud during the rainy season. It may also cause a gravel road to pit after a heavy shower.

Base Course: For the construction of the base course the State of Kentucky requires: (1) The gravel shall be composed of hard, durable rock fragments. (2) It shall be uniformly graded from fine to coarse together with sand. (3) It shall not contain more than 5 per cent of dry weight of organic matter. (4)

There must be no pebbles retained on a 2½ inch screen. (5) Not less than 50 per cent nor more than 75 per cent shall be retained on a ¼ inch screen.

The portion of the gravel which is retained on a ¼ inch screen is known as coarse aggregate. Of this coarse aggregate not less than 25 per cent nor more than 75 per cent shall be retained on a 1 inch screen. The gravel itself shall show a percentage of wear not exceeding 15. It must not contain more than 10 per cent by weight of clayey matter.

The wearing surface consists of a single layer of properly graded gravel. This material shall be spread uniformly and compacted to the requisite thickness.

Maintenance: The maintenance cost is the heaviest during the first year after the completion of the road. If a gravel road begins to pit the material used in patching should be the same as that used in the construction of the road and the patching should be done when the surface is wet for the new material bonds to the old better when wet than when dry. All ditches, drains and culverts should be kept open for two reasons: (1) To keep the run-off water from standing on the surface of the highway. (2) To keep the surface water from being brought up into the base course by capillarity.

In Bowling Green, the county seat of Warren County, there is a short stretch of experimental road that is very interesting. A badly worn water bound macadam needed repair. To one section oil was applied and gravel spread over the oiled surface. Through the agency of continuous traffic much of the gravel has been carried to the sides of the road where it now lies in ridges or winrows. The result is very unsatisfactory. To the other section of this same stretch, the gravel was applied and properly finished for a wearing surface. Then a coat of heavy oil was uniformly spread over the gravel. No rows of gravel appeared at the shoulders of the road this summer (1923), and the results appeared quite satisfactory.

The length of life of any gravel road will depend upon at least five factors: (1) The manner in which it is constructed. (2) The character of the gravel with which it is surfaced. (3) The amount and composition of the bonding material. (4) The

amount and kind of traffic upon the road. (5) The system of maintenance.

Broken Stone Roads.

The various types of rocks used in the different states in road construction may all be included in three classes:

1. Igenous.
2. Sedimentary.
3. Metamorphic.

The igneous rocks are those which have risen in a molten condition from the zone of flowage and subsequently cooled. They may or may not have flowed out over the surface. They may be divided into two classes. (1) The intrusives. (2) The extrusives. The intrusives may be listed as granite, syenite, diorite, gabbro, diabase and peridotite. The extrusives may be listed as rhyolite, trachyte, audesite and basalt.

The sedimentary rocks are those which are formed by the agency of water. They represent either the consolidated products of former rock disintegration or the accumulation of organic remains chiefly calcareous. They may be divided into two classes: (1) Siliceous, (2) calcareous. The siliceous rocks include sandstone, shale and slate. The calcareous rocks include limestone and dolomite.

The metamorphic rocks are those which have been changed by dynamic and chemical agencies. They may be divided into two classes: (1) Foliated. (2) Nonfoliated. The foliated rocks are the gneisses and various schists. The nonfoliated rocks are slate, quartzite and marble.

The igneous rocks are not known to exist in Kentucky save as a few peridotite dikes in the eastern and western parts of the State, but these basic dikes are too narrow wherever they do occur for practical quarrying for road construction.

The metamorphic rocks produced by regional metamorphism over large areas are also wanting in Kentucky. However, some physical and chemical change has been effected in some of the recrystallized limestones where the petrographic microscope proves the entire rock mass to consist of well crystallized calcite. In more than 25 counties in the State either a partial or complete recrystallization of the calcium carbonate has taken place. In restricted areas as along fault planes some of the sandstones have been converted into a very hard quartzite. This holds especially true of the quartzite some two miles south of Smithland in Livingston County, Kentucky. The rocks therefore upon which the State of Kentucky must rely for road building belong to the sedimentary types, the limestones and the sandstones. The shales are too weak for road work.

Limestones: Limestones consist essentially of calcium carbonate. A pure limestone may contain less than 0.5 per cent of constituents other than calcium carbonate. A dolomitic limestone contains an appreciable amount of magnesium carbonate, usually less than 30 per cent, for above that percentage the rock approaches a true dolomite and may therefore be classed as a dolomite. An argillaceous limestone contains clayey matter. A siliceous limestone carries silica, often as minute sand grains. A carbonaceous limestone contains carbonaceous matter which may be reduced to uncombined carbon. A bituminous limestone carries bitumen in some form. Such limestones vary widely in color even from nearly white to black. In texture they grade from fine to coarse. Some of them are very soft and friable while others are compact, hard, and break with an angular or conchoidal fracture.

Sandstones: Sandstones consist of grains of sand bound together by some cementing material. The most common bonding materials are: (1) Calcium carbonate. (2) Clayey matter. (3) Iron oxides. (4) Silica. This is often the cementing material in the quartzites.

Any substance that can bind sand grains together like barium sulphate or calcium sulphate may function as a cement but these cements are rare.

The sandstones vary widely in color, texture and hardness. Some of them are extremely soft, like some of the Peach Orchard sandstones of Eastern Kentucky, while others are very hard like the calcitic sandstone of Johnson County, Kentucky. The hard, compact, dense sandstones make the better road metal. This holds especially true if the interstices among the sand grains have been completely filled with recrystallized calcium carbonate.

Many sandstones are deficient in binding power and break up rapidly under the action of traffic.

Shale: Shale is an indurated clay in which the metamorphism has not been carried to the slate stage. As already intimated they are too soft and friable for road construction. However, they have been used in some instances in the filling where the grading is heavy.

Properties.

A good road stone should meet the following requirements: (1) It should have a good resistance to wear caused by the grinding action of wheels. (2) It should be tough so as to resist the shock of traffic. (3) It should have good cementing qualities so as to bind the dust formed by traffic as well as to hold the entire mass in solid bond. (4) It should give a clear ring under the hammer. A dull sound implies unsoundness. A sound stone will be harder and wear longer than a dead one. (5) It should break with a sharp angular fracture, for such fractures aid in holding the broken stone in place.

Broken Stone: The sizes of broken stone produced by the largest and best equipped rock crushers in Kentucky are as follows:

3 inches.
2½ inches.
2¼ inches.
2 inches.
1½ inches.
1¼ inches.
¾ inch.
½ inch.
⅜ inch.
Dust.

Grading: The grading of the broken stone delivered from rotary screens will depend upon four factors:

(1) The speed with which the screen rotates.
(2) The pitch of the screen.
(3) The length of the holes in the screen.
(4) The diameter of the holes in the screen.

Construction: Broken stone roads are usually constructed in three courses. The larger sizes of broken stone are used in the foundation or subgrade which should be thoroughly compacted with a heavy roller. Gravel and slag have often been substituted for broken stone in the subgrade. Some states specify the size of the stone to be used in the different courses. The State of New York stipulates that the stone for the foundation course must pass through 3½ inch holes and for the upper courses the stone must pass through 2¼ inch holes.

For a broken stone base course, the State of Kentucky specifies: (1) That all material must pass a 3¾ inch sieve. (2) That from 30 to 70 per cent must pass a 2½ inch laboratory screen. (3) That not more than 10 per cent shall pass a 1 inch laboratory screen.

The State of Kentucky further specifies that when a water-bound macadam surface is being constructed simultaneously with the base course the stone for the base shall be that part of the crusher run having the following grading:

(1) Passing 3¾ inch laboratory screen 100 per cent.

(2) Passing 2¾ inch laboratory screen not more than 10 per cent.

That part of the crusher product passing over a 1 inch revolving screen, which is taken out of the surface coarse material, may be mixed uniformly with the base coarse material.

Requisites for Coarse Stone: The coarse stone for the base course should meet the following requirements: (1) The coarse stone shall consist of angular fragments of broken limestone of uniform quality throughout. (2) It shall contain no more than 5 per cent of elongated pieces of stone. (3) It shall be free from soft or disintegrated stone. (4) It shall be free from dirt or other objectionable matter. (5) Its percentage of wear shall not be more than 8.

Coarse Slag: As already intimated earlier in this chapter coarse slag is sometimes substituted for broken stone in the base course. Its requirements are as follows: (1) It shall consist of angular fragments of air cooled, blast furnace slag. (2) The slag shall be reasonably uniform in density and quality. (3) It shall be free from metallic iron. (4) It shall be free from thin or elongated pieces of slag. (5) It shall be free from dirt or

other objectionable matter. (6) It must not be brittle or glassy. (7) The percentage of wear must not exceed 10. (8) It must not weigh less than 75 pounds to the cubic foot when compacted by shaking.

Central Course: The central course for broken stone roads is usually made of the intermediate sizes and then rolled with a 10-ton steam roller to a uniform surface. It sometimes happens that a third layer of stone is added. This layer is also rolled. The number of layers depends upon the thickness of the road about to be constructed. A very thin road may consist of but a single layer. If no roller is used to compact the material to uniform surface the stone is usually spread on the surface of the road bed, to the full thickness desired for the road and left to the compacting action of traffic.

Wearing Surface: The upper layer constitutes the wearing surface of the road. It consists of stone chips and dust rolled to a perfectly smooth and hard surface. The material used must all pass a 1 inch revolving screen. A thin layer of binding material is used in finishing the surface. This may consist of small chips, dust, small gravel, sand, a loam, or even clay. Whatever type is used, the product is washed, and rolled into the interstices of the rock so as to form a compact and impervious wearing surface. The objects are: (1) To fill all the voids as completely as possible. (2) To make the road one solid mass. (3) To bind the rock firmly together. (4) To prevent the percolation of water through the surface. The last three factors are largely dependent upon the first.

It sometimes happens that a given quarry produces a comparatively small tonnage of screenings for this work. It then becomes necessary to secure an adequate supply of screenings from some other quarry. Screenings constitute only a small part of the total weight of stone used. Therefore the cost of longer haulage is not prohibitive.

Maintenance: Many a water bound macadam road has soon become exceedingly rough and unsatisfactory simply by neglect. A maintenance man should be employed to repair all pits and ruts as soon as they appear. The stone and screenings used should be of the same sizes and composition as those used in the original construction of the road. To maintain a broken stone road in good condition it is necessary: (1) To frequently remove the mud and dust that has accumulated upon it. (2) To keep the culverts and ditches open to insure the prompt discharge of all water that may fall upon the surface of the road. Broken stone roads are often sprinkled with water to prevent raveling in dry weather and to avoid the formation of excessive dust.

Causes of Pits and Ruts: The causes of pits and ruts may be listed as follows:

(1) Water standing on the surface of the highway.

(2) Water brought up by capillarity from imperfectly drained roads.

(3) Pockets of stone of smaller dimension than those used in the main body of the road.

(4) Pockets rich in shale content. This often happens when limestones intercalated with shale beds are used.

(5) Pockets rich in soil content.

(6) The steady tramp of horses' feet in one path.

(7) The wear of light and heavy vehicles in one path.

(8) The unequal production of dust produced by traffic.

(9) The displacement of stone by the action of traffic.

(10) Too heavy motor traffic for a given type of road.

(11) Inadequate drainage of the road bed.

(12) The picking up of the macadam surface by muddy wheels of vehicles that have just come over intersecting clayey roads.

Bituminous Roads.

A wide variety of bituminous materials are used in the upper surfaces of roads and pavements. They are derived from many different sources and possess varied properties. For their nomenclature, chemical composition and sources of origin the reader is referred to Chapter X in the text book of highway engineering, by Blanchard and Drowne.

Kentucky is particularly rich in her supply of rock asphalt for road construction. Its abundance, its richness in asphalt and its value as a road surfacing material have given the pro-

duct not only an interstate reputation but also an international reputation.

Rock Asphalt: Rock asphalt is the name applied to a great variety of sandstones and limestones more or less impregnated with malthas. Malthas are viscous native bitumens. Asphaltic sandstones also occur in Alabama, California, Oklahoma, Utah and West Virginia. Bituminous limestones exist in Kentucky, Oklahoma, Texas and Utah.

Rock asphalt pavements have their wearing surface composed of pulverized rock asphalt with or without the addition of bituminous material. Sheet asphalt pavements have their wearing surface composed of sand of predetermined grading, fine material, and asphalt cement incorporated together by mixing methods.

Bituminous macadam consists of broken stone and bituminous materials incorporated together by penetration methods.

Native asphalts are solid or semi-solid bitumens. The asphalt deposits of Trinidad and Bermuda are true native asphalts.

The following is a list of the heavier bituminous materials that have been used in the United States in the past few years for bituminous road construction: (1) Rock asphalt. (2) Residual asphalt. (3) Fluxed native asphalts. (4) Oil asphalt. (5) Semi-asphaltic oils. (6) Light oils. (7) Coke oven tars. (8) Coal gas tars. (9) Combination of asphaltic material and tars.

Bituminous Macadam Surface: For a bituminous macadam surface of the penetration type in Kentucky fluxed native asphalts, oil asphalts and refined tars are used. When the coarse stone base is ready for surface treatment there is spread over the surface 1½ to 1¾ gallons of bituminous binder to each square yard of surface area. If the binder is an asphalt it must be applied at a temperature of not less than 275° F. If the binder is a tar product it must be applied at a temperature of not less than 200° F. and not more than 250° F. The bituminous binder is evenly spread over the surface by pressure distributors.

While the bituminous binder is still warm a layer of intermediate aggregate is spread uniformly over the surface in sufficient quantity to just fill the surface voids. It is then rolled

until well compacted, swept clean of all loose stone and the seal coat applied. This coat requires ½ gallon to ¾ gallon of the bituminous binder to the square yard of surface. The surface is then covered with a thin layer of limestone chips or torpedo gravel and lightly rolled.

Rock Asphalt Surface: This surface consists of a compacted layer of rock asphalt laid on a base course of one of the following materials: (1) Cement concrete. (2) Broken stone. (3) Broken slag. (4) Gravel. (5) Asphaltic macadam.

The requirements for the rock asphalt are as follows:

(1) It shall consist of a natural mixture of mineral aggregate and bitumen of uniform quality throughout.

(2) It shall contain not less than 6 per cent of bitumen soluble in cold carbon disulphide when tested in accordance with the bulletin No. 314 of the U. S. Department of Agriculture.

(3) The hydrated material shall have a loss upon ignition of not less than 7 per cent nor more than 9 per cent.

(4) The material shall be free from foreign matter.

(5) It shall be pulverized so that not less than 95 per cent will pass a ¾ inch screen.

(6) Not more than 20 per cent shall be retained on a ¼ inch screen.

The rock asphalt used must contain a uniform percentage of bitumen in order to give uniform results, results that are reasonably satisfactory. Some rock asphalts within the State of lower limit of content than that required may be enriched within narrow limits by asphalts exceeding 9 per cent of volatile matter by the ignition test. There is, however, need of research along this line for rich rock asphalt does not mix readily with lean rock asphalt by present methods.

Sheet Asphalt: It is necessary that sheet asphalt be laid upon a very firm, unyielding foundation for three reasons: (1) It has no power to sustain loads that pass over it. (2) It must be held in place from beneath. (3) It acts only as a wearing surface.

The foundation upon which sheet asphalt rests is usually a bituminous base. It may be a bituminous base or even a macadam base. The concrete base consists of hydraulic cement mortar and broken stone. The mortar must be fully set and

the concrete thoroughly dry to prevent blistering when the asphalt is laid. The thickness of the concrete base varies from 4 to 6 inches depending upon the following factors: (1) The amount and kind of traffic that passes over it. (2) The nature of the road bed. (3) The drainage of the subsoil.

Binder: The binder course for sheet asphalt is placed between the concrete base and the surface layer. The material consists of broken stone which passes thru a 1 inch screen and mixed with sufficient bitumen to throughly coat every piece of stone. The thickness of the course is usually about 1½ inches. This binder course should: (1) Consolidate with the surface. (2) Add strength to the surface. (3) Increase the depth of the consolidated portion of the road. (4) Prevent the wearing surface from cracking. (5) Prevent the wearing surface from waving or ribbing.

Surface: The wearing course of sheet asphalt is carefully spread over the binder course. Its thickness is usually from 1¼ to 1½ inches but if the type of construction is single course work then the sheet asphalt is usually laid in a course varying from 2 to 2½ inches in thickness. The warm asphalt is spread over the binder with hot rakes All lumps are broken up. All compacted material is loosened so that under the roller it may compact to a uniform density. In rolling a 2 to 4 ton roller is first used. Then a 6 to 8 ton roller completes the shaping of the pavement. A thin coating of hydraulic cement is spread over the surface before the final rolling to give proper color to the surface.

In order for sheet asphalt roads to give satisfactory results it is necessary that: (1) The subgrade be properly drained. (2) The base course properly constructed. (3) The asphalt laid by men of experience and skill. (4) The asphalt evenly distributed that it may not become uneven and wavy under traffic. (5) The rolling carefully executed to properly compress the asphalt into the required form.

To prevent sheet asphalt pavements from unsightly zigzag cracking three possibilities are suggested:

(1) That the borders of the base course of crushed stone or gravel be equal in thickness to the center of the course.

(2) That a longitudinal expansion joint be placed in the exact center of the pavement.

(3) That cross expansion joints be introduced only at the close of a day's work, or where work has ceased for more than one hour.

Maintenance: The life of an asphalt pavement more than that of any other wearing surface demands cleanliness for several reasons: (1) Dirt in wet weather causes an asphalt pavement to decompose. (2) Dirt in wet weather makes the pavement more slippery. (3) It permits the pavements to wear away more rapidly.

In order to keep the surface of asphalt pavements in good condition it is necessary for a maintenance man to repair small breaks as fast as they appear. This is easily done if taken in time, but only at considerable expense if not done then, for small breaks rapidly become large pits through the action of traffic.

Causes of Pits: The causes of pits in the various types of roads may in part at least be listed as follows:

(1) Pockets of stone of smaller dimensions than the main body of the road.

(2) Pockets of shale which quickly soften during a rain.

(3) Pockets of dirt that were fed into the crusher and subsequently appeared in the crushed stone.

(4) Unequal or insufficient bonding material.

(5) Unequal distribution of oil over wearing surfaces that are oiled from time to time.

(6) The greater capillarity of the finer materials thereby bringing up moisture from beneath.

(7) Improper drainage of the road bed.

(8) Insufficient binding material between rock asphalt and the road bed.

(9) The greater settling of the sides for when the rock bed is thinner at the sides than at the center it pulls the materials away from the center causing cracks. This is tension.

(10) Imperfect construction of road bed, base course and wearing surface.

(11) The stamping of horses when hitched or unhitched and allowed to stand for some time at the side of paved streets.

The author saw this summer in Cairo, Ill., a vivid illustration of an asphalt mutilated to a depth of 2 inches by the calks on horses' shoes.

(12) The escape of illuminating gas from leaking mains. This cause was observed by A. W. Dow of Washington, D. C. The heavy hydrocarbons of the gas were absorbed by the bitumen of the asphalt, which was softened and caused to be cut and flow under the agency of traffic.

CHAPTER V.

EASTERN KENTUCKY.

The area embraced in eastern Kentucky includes all the eastern part of the State and the knobs adjacent to the region. Many of the knobs border the Bluegrass section on the east. The western boundary may be marked by a line drawn approximately north 45 degrees east through Clinton, Wayne, Pulaski, Rockcastle, Estill, Powell, Menifee, Rowan and Lewis counties. The last county mentioned borders the Ohio River. The 36 counties embraced in this geographic province will be listed in alphabetical order and all quarries known to the author cited and located. This arrangement will aid materially in finding information concerning the road building materials of the various counties.

On the map of Eastern Kentucky which accompanies this discussion will be located the different quarries whether active or inactive, large or small, meeting the State requirements for Federal roads or failing to meet these requirements. The geologic age of the limestones and sandstones represented in the various counties of the State has been given in the building stones of Kentucky.* In this report the age of the different geologic formations represented in each of the 120 counties of the State is also presented.

Bell County.

Ten quarries either active or inactive were located in this county. They are all in sandstones save the Jack Asher quarry.

1. The Jack Asher quarry is situated about 30 rods south of the Louisville and Nashville Railroad station at Pineville, where, by the Pine Mountain fault, with displacement of 1,500 feet or more, the Upper Mississippian limestone has been brought into view. The quarry opening is approximately 200 feet in length, 100 feet in width, and the quarry face was estimated

*Kentucky Geological Survey, Series VI., Vol. XI. 1923.

100 feet in height. The uppermost beds are of sandstone, which is not regarded as good road metal.

The upper portion of the limestone comprises about 40 feet of well crystallized limestones, reasonably free from chert nodules. This would make a fairly satisfactory road building stone. The lower 50 feet consists of a dark gray semi-crystalline limestone with chert nodules more or less scattered through the stone. The cherty limestones elsewhere in the State have been used for road work.

2. The Joseph Smith quarry, operated by Tom Caton, is situated within the city limits, one-fourth of a mile north of the Continental Hotel. It is a bluish sandstone which weathers dark on exposure to the atmosphere.

3. This quarry is situated within 300 yards of the Louisville & Nashville freight depot. A quarry has been opened at the south end of a bluff extending north and south along the railroad. The stone is slightly bluish gray, very fine grained, and somewhat micaceous. It appears a little softer than the stone at the north end of the same bluff. The stone should be tested for its per cent of wear.

4. At the north end of the same bluff there is an abandoned quarry of bluish gray, fine grained, slightly micaceous sandstone that would make a most excellent building stone. It is free from iron, hammers white, and is very pleasing in its effect. A quarry opening 1,000 feet in length of working face, with height of 50 feet, could easily be effected. Some of the beds are more than 10 feet in thickness, without seam or flaw.

5. Near where the Louisville & Nashville Railroad crosses Bennett's Branch just north of the Kentucky-Tennessee State line there is a small quarry of fine grained, micaceous sandstone of good quality. This quarry is about 3 miles southwest of Middlesboro.

6. This quarry is located near the mouth of Bearfork Branch of Stony Fork some 2 miles west of Middlesboro. This stone is fine grained and micaceous.

7. This quarry is situated near the mouth of Hignite Creek about 4 miles west of Middlesboro and just to the north of a branch of the Louisville & Nashville Railroad. The stone appears the same as in No. 6.

8. This quarry is located on Stony Fork, 5 miles west of Middlesboro. The stone for the American Association building in Middlesboro came from this quarry.

9. There is a small quarry 10 miles west of Middlesboro near the junction of Clear Fork and Sowder Creek. The stone for the piers and abutments of the Louisville & Nashville bridge over Clear Fork came from this quarry. The stone is of pinkish color, of medium grain, and weathers well.

10. This quarry is situated near the junction of Brown's Branch and Yellow Creek about 3 miles north of Middlesboro. It is close to the Louisville & Nashville Railroad on the State road from Middlesboro to Pineville. It is therefore the most accessible of all the quarries in the lower half of Bell county. The stone is fine grained, bluish gray, and should be satisfactory for road building purposes.

Boyd County.

Nine quarries were listed in Boyd County. They are all in sandstones.

In general they are regarded as too soft for road building purposes but they contain some hard bluish gray layers. There is at least one hard sandstone or quartzite at Cannonsburg which is described later. Five of these quarries are just southwest of the Chesapeake & Ohio Railroad and only a few rods to the southwest of the Ohio River. The other four are situated to the east or southeast of the Louisville division of the Chesapeake & Ohio Railroad and strictly speaking they are quarry prospects.

The bluffs to the left of the road between Ashland and Greenup County line carry from 20 to 40 feet of bluff to yellowish white sandstone that is too soft for the coarse aggregate in concrete. It has been used to quite an extent in constructional work, for riprap and rubble masonry. Beneath this soft sandstone there is 15 to 20 feet of hard bluish gray sandstone that can be used in road work but the overburden is heavy. This condition holds true throughout Boyd County. Therefore the use of slag from the iron furnaces is preferred.

(1) The quarry of the Ashland Cement & Construction Company is 1 mile northwest of Ashland. The stone is of dark

bluish gray color, micaceous, of medium texture, and somewhat banded. It has been used to quite an extent in construction work.

(2) The John Paul Jones quarry is situated 1½ miles

1. ROCK CUT 1 MILE NORTH OF ASHLAND, KY.
The lower beds are compact, bluish gray, micaceous sandstone.

northwest of Ashland in the same range of bluffs as No. 1. The quarry is now abandoned, although much stone can be obtained at this site.

(3) This is an abandoned quarry 3 miles northwest of Ashland. Stone was quarried here some 17 or 18 years ago for the coke ovens of the Ashland Iron & Mining Company.

(4) At the Cliffside Bluffs, 2 miles south of Ashland there is a very massive, somewhat bluish gray, slightly micaceous sandstone which occurs in beds several feet in thickness. A quarry could easily be opened here, with a 50-foot working face. Furthermore, such a quarry would be only a few rods from the railroad for shipping the quarry products. A little further to the west on this line of bluffs there are sandstone exposures with

individual beds from 10 to 20 feet in thickness that should make a fair road building stone.

(5) This quarry is situated within the city limits of Catletsburg, the county seat. It is a massive, thick bedded, bluish gray, micaceous sandstone that is fairly well suited for constructional work. The numerous spalls from this quarry show few if any ill effects of weathering. The quarry is abandoned because of the close proximity of dwelling houses.

(6) This quarry possibility is situated a little south of Summit Herd. The rock is a white to creamy white, medium grained sandstone, occurring in beds of merchantable thickness.

(7) This quarry possibly occurs at Princess. It is in the same white or yellowish white medium grained sandstone formation as No. 6.

(8) A cut made in the construction of the permanent roads over Laurel Hill was made through a more or less massive bluish gray, fine grained and micaceous sandstone that is of especial interest in view of the character of the sandstone near Cannonsburg.

(9) This cut was made in the construction of a permanent road from Ashland to Cannonsburg. This sandstone is very hard, compact, calcitic, micaceous and arkosic. The calcite is for the most part well crystallized and is the interstitial material surrounding the grains of the other minerals. The few well-rounded quartz grains have been derived from the decomposition of an unknown quartzite, which appears as microscopic pebbles in the rock. The most of the quartz grains are large and angular, suggesting residual quartz. This angularity is so pronounced that it is evident to the observer that the material could not have suffered transportation to any considerable distance.

The angularity of the large quartz grains, the abundance of the feldspars, orthoclase, microline and albite, the numerous scales of muscovite, arranged somewhat in parallel layers in the hand samples, together with the paucity of biotite crystals, suggests that the rock was derived from a muscovite granite low in its biotite content. If the evidence is correctly translated, then this arkose has written a new chapter in the geologic history of Kentucky. Granitic intrusions of unknown age invaded sediments of unknown age, possibly Cambrian, which suffered ero-

sion of probably 5,000 feet of overlying strata before Mississippian time. The granite mass may have been an island during Mississippian and early Pennsylvanian time. The sediments comprising this Boyd County, Kentucky, arkose are regarded as having been deposited upon its flanks near the close of the Pennsylvanian in Kentucky.

As this type of rock has not been found before in Kentucky the formation is named the Cannonsburg quartzite. Detailed field work and petrographic study will be necessary to determine the extent of the formation. The supply is sufficient to warrant opening a quarry for a cut on the Midland Trail passed through approximately 75 feet of this rock. At least a depth of from 10 to 20 feet of rock can be secured. This rock has a percentage of wear of only 3.7. The amount of water absorbed in 24 hours is 1 part in 215 parts. It meets State specifications for base course, concrete and rubble masonry.

A more calcitic phase of this quartzite is found in blocks along the shoulders of the highway near the cut in the Cannonsburg quartzite. These blocks were not transported any considerable distance and probably this calcitic phase encircles the more massive quartzite. If in opening a quarry here this rock should be found in abundance it would be very fortunate on account of its high calcite content.

Gravel: Gravel for use in concrete in Boyd County is obtained from the Ohio River near Huntington, West Virginia.

Breathitt County.

The seven quarries in Breathitt County are all in sandstone. Most of them are in the drab or gray sandstone that usually meets the specifications for base course.

1. This is a small quarry near Jackson in a yellowish brown sandstone that is somewhat softer than the underlying gray sandstones.

2. This quarry is at station 323-324, Jackson-Campton road. 13½ miles northwest of Jackson. It is drab in color, and is located on the farm of S. H. Hurst.

3. This quarry is at station 296 on the farm of S. H. Hurst 13 miles northwest of Jackson. It is in the drab sandstone.

4. This quarry is at station 258+50 on the farm of S. H. Hurst 12½ miles northwest of Jackson. The color of the stone is drab. The quarry is small.

5. This quarry is at station 92, on the farm of Wm. Fay, 7 miles northwest of Jackson.

6. This quarry is at station 114-115 on the farm of W. H. Pilfrey, 7¾ miles northwest of Jackson. The color of the stone is drab and the supply practically inexhaustible.

7. This quarry is on Johnson Forks of Frozen Creek at station 210, 9¾ miles northwest of Jackson. The color of the stone is brown and the supply ample.

The above station numbers refer to the new Federal road survey of 1923.

Gravel: Breathitt County has at least two good gravel deposits. It contains some material that can be used as sand. The percentage of loam in the sand is not too high.

1. This gravel deposit is on Little Frozen Creek at station 81+50, 7¼ miles northwest of Jackson.

2. This gravel deposit is on Johnson's Fork of Frozen Creek at station 219. 8 miles northwest of Jackson.

Carter County.

There are eleven quarries located in Carter County, mostly in limestone of Mississippian age. Seven of the quarries are located along the Chespeake & Ohio Railroad. The limestones are with one exception non-dolomitic.

(1) This quarry is situated at Highland, near Enterprise. It is owned and operated by the Olive Hill Limestone Company. The limestone is massive, with some beds bluish gray and others nearly white in color. It is silieeous and contains some clayey matter. The calcium carbonate content is 50.00 per cent, and the magnesium carbonate reaches 21.36 per cent. It is therefore strongly dolomitic, but the magnesium carbonate is not sufficiently high for the rock to be classed as a true dolomite.

(2) This quarry is situated at Lawton. The individual beds sometimes reach a thickness of 4 feet. The stone ranges in color from a grayish white to nearly white. The rift and grain of the stone are good. The calcium carbonate content

is 96.28 per cent and according to the chemist of the Libby-Owens Glass Company of Toledo, Ohio, there is no magnesium carbonate present, and only a faint trace of iron oxides.

(3) This quarry is located at Limestone. It is owned and operated by the Olive Hill Limestone Company. The quarry is about 500 feet in length, 200 feet in breadth, and 65 feet in depth. The limestone is hard and breaks with a conchoidal fracture. It is somewhat metamorphosed, for it carries narrow veins with crystals of calcite. The iron oxide content is only 0.47 per cent, and the clayey matter is very low. It is non-dolomitic.

(4) This quarry is about 1 mile east of Olive Hill on the north side of the railroad. It is owned and operated by the Olive Hill Limestone Company. It is some 800 feet in length, 200 feet in breadth, with a working face of approximately 83 feet. Some of the beds are 22 feet in thickness. Some of them are quite crystalline and would make a very good road building stone. This holds especially true in the lower portions of the quarry. A few of the thinner beds contain much clayey matter, and neither wear nor weather well. This quarry formerly belonged to the Atlas Stone Company.

(5) This quarry is situated on the south side of the railroad about one-fourth mile from No. 4. It is known as the Highland quarry. The characteristics of the limestone at this quarry are the same as at No. 4, and the entire output is used as crushed stone for road building, railroad ballast, street work and the construction of the Midland Trail.

This quarry extends into the hill to the south, while No. 4 extends into the hill to the north. Each with an increasing depth of working face.

(6) This quarry is at Grayson. It is reached by the Eastern Kentucky Railroad extending north from Hitchins. According to D. S. L. Warnock, contractor and builder, Grayson, Kentucky, the quarry possibilities are large, and the stone suitable for road metal.

(7) This quarry is located at Carter. It is reached by a spur of the Chesapeake & Ohio Railroad from Garrison. There is a large crusher here, and the stone is used along the Chesapeake & Ohio Railroad.

(8) This quarry is located about 1 mile west of Carter on

the spur of the Chespeake & Ohio Railroad. The stone is like that in quarry 7.

(9) This quarry is situated on the John B. Gregory estate, now owned by Harriet Gregory Barney, about 5 miles from Grayson and 10 miles from Olive Hill. The quarry was opened up to furnish stone for bridges, culverts, and construction of the Midland Trail. This stone is one of the best in eastern Kentucky. It is grayish white in color, fine to medium grained, oolitic in texture, and semi-crystallized. It is an excellent road building stone.

(10) This quarry is in sandstone rather than limestone, and is situated at Lawton. The quarry is owned by the Camp Glass Company of Huntington, West Virginia. The purer beds are from 2 to 4 feet in thickness, white or yellowish white in color, and with little cementing material binding the sand grains together. The percentage of quartz sand is 99.45 with only 0.04 per cent of iron oxides. It is not a road building stone.

(11) The General Refractories Company of Olive Hill operate a small quarry of sandstone which is situated about one-half mile west of their factory. The lower 15 feet in the quarry is white or faintly yellowish white in color, but too brittle for constructional work.

Along the Chesapeake & Ohio Railroad between Grahn and Leon there are huge bluffs of a massive yellowish white sandstone. Some of the beds are 25 to 50 feet in thickness. They are Pennsylvanian in age. It could not be ascertained that any quarrying had ever been done in this section. The area is worthy of investigation. W. M. Jarvis, District Engineer, Ashland, regards these sandstones as too soft for the base course.

(12) This quarry is situated within 50 feet of station 55 on the Midland Trail and within ½ mile of Soldier. The sandstone is fine grained, thin bedded and certain beds are highly fossiliferous.

(13) This quarry is ½ mile north of station 156 and 5 miles north of Soldier. This sandstone is a good road metal.

(14) This quarry is 50 feet north of station 177 and 5½ miles north of Soldier. This sandstone is reported by L. S. Coburn, Resident Engineer, as very good for road work.

Rock Asphalt: Sandstones more or less impregnated with

asphalt material occur at Soldier—the western part of Carter County. These deposits are situated on both sides of the Chesapeake & Ohio Railroad and within ½ mile of the railroad station at Soldier. The deposit is estimated as approximately 3 miles in length and the breadth as ¾ mile. The thickness of asphaltic rock varies from 4 to 22 feet, with a conservative estimate of an average of 7 feet. It is estimated by S. M. Bradley of Morehead that there are 1,000 acres of merchantable asphalt in Carter County.

The asphalt content is reported to average 7 per cent and therefore to meet the State requirements for road construction. An analysis of a sample from the farm of S. M. Bradley gave volatile combustible matter 6.53 per cent. Bituminous matter extracted by carbon disulphide 7.13 per cent. Three samples analyzed from the farm of Mrs. J. B. Danner failed to meet State requirements. This rock asphalt has been described.* It is reported to carry a lighter oil than the deposits of Edmonson County.

Clay County.

There are no quarries known to the author in Clay County, yet there are several quarry possibilities. The sandstones are white to grayish white in color. The sandstone overlying the Burns coal is medium to coarse grained and massive. The remaining sandstones are fine grained and massive. The thickness of these sandstone outcrops ranges from 40 to 50 feet.

Clinton County.

There are seven quarries in Clinton County. They are all in limestone.

(1) Albany Quarry. This quarry is situated just north of Albany. The stone is of light blue color and weathers well.

(2) Graded School Quarry. This quarry is situated just east of Albany and furnished the stone for the foundation of the graded school.

(3) This quarry is some 4 miles west of Albany on the Albany-Cartwright-Monticello pike. It has furnished much blue

* See Bibliography No. 27.

and gray limestone for road work. The beds are from one to two feet in thickness and massive.

(4) This quarry is on Guinn Mountain, formerly called Poplar Mountain, and is some 6 miles from Albany. Here the oolitic and semi-oolitic limestones attain a thickness approximately 150 feet, and should furnish much excellent road building stone for local uses.

(5) Some 4 miles north of Albany toward Seventy-six there are many thick beds of massive limestone of blue to bluish gray color that could furnish good road building stone.

(6) This quarry is situated about 50 feet northwest of station 230 on the farm of L. Perdue, 12½ miles northwest of Albany. The percentage of wear in this limestone is 3.7. Therefore it meets the State requirement.

(7) This quarry is situated at station 22, on the farm of Mrs. W. O. McWharter, 7½ miles northeast of Albany. The percentage of wear in this limestone is 5.7. Therefore it meets State requirements. The supply of the stone is ample.

Elliott County.

The terranes of Elliott County are prevailingly of sedimentary origin, save the small area of peridotite dikes in the eastern part of the county. The sandstones are massive, of bluish gray and yellowish white color, and sometimes furnish beds 50 feet or more in thickness. They contain beds sufficiently pure for local use, and it probably has been used in Sandy Hook.

Elliott County is one of the four counties of Kentucky invaded by intrusives. These basic igneous rocks occur as dikes in the hills on each side of Ison Creek just west of Stephens in the eastern part of the county. They came from the zone of flowage in the interior of the earth, but did not flow out over the surface as lava. The area traversed by these dikes covers only a few acres, and all of the isolated masses may logically be considered parts of a single intrusion, for they are identical in mineral composition. These peridotites if they occurred in sufficient abundance and were not so greatly decayed would make a good road metal but distance from railroad limits their use.

An opening has been made in one of these dikes to a con-

siderable depth. It assumes the aspect of a shaft more than that of a quarry.

Estill County.

One quarry exists in Estill County. This quarry is in the lithographic limestone. The individual beds are not as thick as those at Solenhofen, Bavaria, yet the stone is fairly satisfactory for lithographic work.

Near Cottage furnace the limestone beds are of merchantable thickness. The stone is of medium gray color, fine grained and granular. Its calcium carbonate content is 92.02 per cent. In this formation there should be found a good road building stone.

Floyd County.

All the terranes of Floyd County are sandstones. Some of them are used extensively as the course aggregate in concrete.

2. CUT IN MASSIVE SANDSTONE.
This cut shows the thick bedded, massive sandstone back of a siding to a coal tipple at Banner, Floyd County, Ky.

(1) There is an abandoned quarry 150 yards west of West Prestonsburg which was in active operation some 15 years ago.

3. CUT IN BLUISH GRAY SANDSTONE
This cut is at Beaver Creek, Floyd County, Ky.

The stone is bluish gray in color, fine grained, and of even texture. Some of the individual beds are 8 to 10 feet thick. The total thickness of the working face could easily be 50 feet. The quarry is now owned by H. H. Fitzpatrick of Prestonsburg.

(2) This quarry is owned by Mrs. Josie D. Harkins of Prestonsburg. It is situated one-half mile from Prestonsburg on

the east side of the Levisa River. A working face of 1,000 feet in length and 50 feet in height could easily be obtained. The stone is white to a yellowish white in color, fine to medium grained, with some surfaces long exposed somewhat iron stained. The quarry opening is now small, but stones for local use could easily be secured.

(3) The quarry owned by L. P. May and Thomas Lanhan is situated 1 mile from Prestonsburg on the east side of the Levisa River. It is used for curbing, foundation work and paving the streets of Prestonsburg. A 30-ton crusher is at work here.

This quarry was sampled this summer for the State. A part of the sample was a bluish gray sandstone and a part was a reddish brown sandstone. Prof. Terrell reports the percentage of wear on this sample as 10.3. Therefore it does not meet State specifications. It is not known to which of the above varieties the high percentage of wear is due. Therefore, this quarry should be resampled. This is especially true since the stone is now being used by W. T. Mellon as the coarse aggregate in concrete for paving with good satisfaction.

(4) The Anna Mayo quarry is situated 2 miles above Prestonsburg on the east side of the Levisa River. The stone is white to yellowish white in color, of medium texture, with perfect rift and grain. The stone is being quarried for bridge purposes and foundation work. It is pure white, and is pleasing in its effect. Along this ridge a quarry opening can be secured more than 1,000 feet in length, with a height of working face more than 50 feet. The purer and better blocks should be saved for constructional work, and the grout used in rubble masonry.

(5) At Cliff, some 2 miles below Prestonsburg on the Chesapeake & Ohio Railroad, this same sandstone appears in beds from 30 to 40 feet in thickness. Some of the blocks are fairly white while others are iron stained by the iron content of the soil overburden. No recent work has been done at this opening.

(6) Just below Banner, some 10 miles above Prestonsburg and on the west side of the Levisa, a drab colored, fine grained, even textured, massive, micaceous sandstone, has been quarried for a retaining wall for a siding to a coal tipple. The stone

weathers well, and some 5,000 cubic feet of the stone has been quarried.

Greenup County.

There is but one quarry known to exist in Greenup County. This is at Mandy in the extreme southeastern corner of the county. At this quarry there is 15 feet of grayish white sandstone beneath which there is 20 feet of massive, hard, bluish gray, somewhat micaceous sandstone. This lower bed is fine grained, of even texture, and could be used locally in road construction.

Gravel: Gravel for use in the manufacture of concrete is obtained from the Ohio River opposite Ironton, Ohio.

Harlan County.

There is but one quarry listed for Harlan County. This is at Harlan. The quarry is in massive sandstone. The product is used locally for foundations, curbing and paving.

Jackson County.

No quarry is known to the author to exist in Jackson County. However, good road building stone should be found in the limestones in the northwestern part of the county.

Johnson County.

There are eight quarries or quarry prospects in Johnson County. With two exceptions they are all situated on or near the Mayo Trail. They are all in neutral gray to dark gray sandstone.

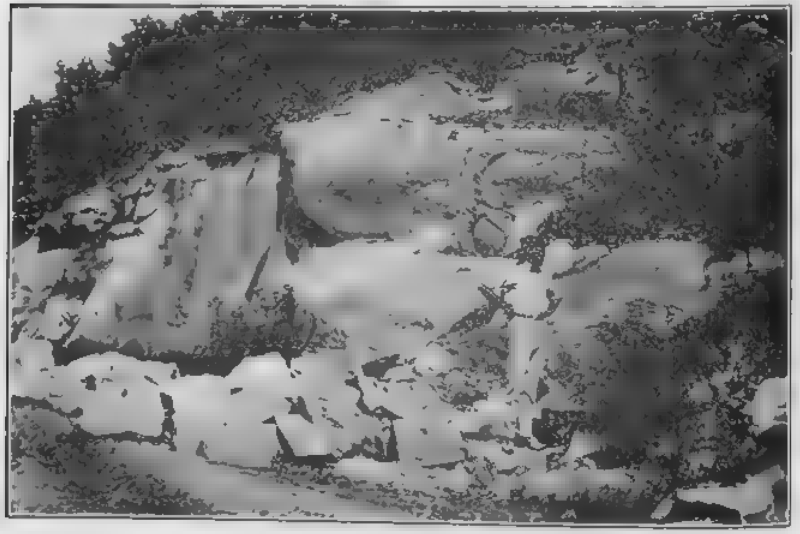
(1) This quarry is on the farm of Bud Stafford just outside the city limits of Paintsville. It was active in 1909 but it is now idle. The supply of stone is ample. There is every reason to believe that it would pass the State requirements for base course.

This sandstone is of a neutral gray color, fine to medium grain, even texture, micaceous, sufficiently soft to work easily, sufficiently hard to cut to a sharp edge, and with good rift and grain. The aluminum content is sufficiently high to suggest that this sandstone is arkosic.

It is not definitely known that this formation has ever re-

ceived a definite stratigraphical name. Therefore, the name Paintsville sandstone is proposed, which upon petrographic study may later be changed, if sufficiently arkosic, to Paintsville Arkose. It is at Paintsville that this formation reaches its best development as a road building stone.

(2) This quarry is situated ¼ mile south of the Chesa-



4. QUARRY ON MAYO TRAIL.
This quarry is situated 1½ miles up Paint Creek from Paintsville, Johnson County, Ky.

peake & Ohio Railroad station at Paintsville on the crest of the hill on the Van Lear pike. It is on property owned by Jackson Vanhoose of Paintsville. The quarry possibility stretches in a southerly direction for 1,000 feet with a possibility of 40 feet vertical face. The stone is netural gray in color and somewhat micaceous. It is thicker bedded at the northern extremity of the bluff. It has been quarried near both ends of the bluff. This quarry was sampled this summer. The percentage of wear was 10.1. Therefore it did not meet the State requirements. This high percentage of wear may have been due to the fact that the sample was taken from the face of a quarry that has been idle for 14 years.

(3) This quarry is situated about 100 rods north of the

railroad station at Paintsville. The stone has been used in street construction.

(4) This quarry is on the Mayo Trail Project No. 77, 1 mile up Paint Creek from Paintsville. The stone has been

5. POSSIBLE QUARRY IN SANDSTONE.
This quarry is situated ½ mile south of Paintsville, Johnson County, Ky.

quarried for road work, foundation stone, masonry, etc. The length of the quarry is about 150 feet. The height is about 40 feet. The supply is abundant but the stone is regarded as only fair. The overburden is light.

(5) This quarry is also on the Mayo Trail between Tays Branch and Turners Branch. A quarry face 200 feet in length could be easily secured with a height of working face of 50 feet. There is but little overburden. The stone has been quarried for road construction, masonry, etc., and is considered very good.

(6) This quarry is situated near the mouth of Turners Branch. It is smaller than either quarry No. 4 or No. 5. It has been sampled and met the State specifications for rubble masonry.

(7) This quarry is situated ½ mile up Turners Branch on the east side of the Mayo Trail. The length of the working face 100 feet. The height of 50 feet could easily be obtained. There

is but very little overburden. The stone is regarded as good. The stone is being used for rubble masonry.

(8) This quarry is situated some 3 or 4 miles north of No. 7 on the Mayo Trail and on the opposite side of the divide. It is a calcitic sandstone or quartzite for calcite fills the interstices among the sand grains. The calcium carbonate should furnish sufficient binding material to recement the dust as rapidly as it is produced by traffic. This quarry was sampled, tested by Prof. Terrell, and the percentage of wear found to be 2.0. The stone is therefore one of the most resistant to abrasion of all road building rock. It meets State specifications and is regarded as very good.

Knott County.

One small quarry is located at Hindman in Knott County but the sandstone here is regarded as too soft for road material. It is of Pottsville age. This, however, does not preclude the possibility of quarrying good sandstones elsewhere for local road construction.

Knox County.

The four quarries in Knox County are all in sandstone. This sandstone is of neutral gray color, fine to medium grained, even textured and works easily. The quarries are all similar in structure and mineral composition.

(1) This quarry is situated about one-half mile east of Barbourville. The quarry is said to be owned by F. D. Sampson, Judge of the Court of Appeals. It is a good road building stone.

(2) The Judge Tuggle quarry is situated about 1 mile northwest of Barbourville. The stone has been used quite a little locally.

(3) This quarry is situated some 3 or 4 miles to the southeast of Barbourville on Fighting Creek. It is on land owned by Mrs. Raswick. The stone is harder than at either of the quarries mentioned, and is therefore better for road work.

(4) A quarry not visited by the author was reported to exist at Heidrick, and the stone said to be used locally for road building purposes.

Laurel County.

(1) There is a large quarry in Chester limestone, 1 mile south of Livingston, on the east side of the Louisville & Nashville Railroad. The individual beds are from 2 to 5 feet in thickness. The stone is of steel gray color, fine grained, dolomitic and a fine road building stone.

(2) According to J. R. Dumme, Field Testing Engineer, a quarry possibility in sandstone is situated 20 feet to the right of station 129. The percentage of wear in this stone is 8.2.

(3) This quarry possibility is situated 10 feet to the right of station 22. The percentage of wear is 8.4.

These last two samples are practically the same sandstone. While the abrasion is a little high for use as the coarse aggregate in concrete, a mix has been effected by the addition of a little extra cement in the State testing laboratory at Lexington that gives the product the required strength for bridge or road work.

Lawrence County.

The possible road building rocks of Lawrence County are all sandstones save a quarry project at Vessie. The sandstones are very abundant. The most of them are too friable to meet the State requirements for base course. As a rule these sandstones will not bear the cost of long transportation, but as local road building stones they have proved of value in the construction of curbing and culverts for railroads. Some of the sandstones can be cut into blocks of considerable dimension, but the most of it is better suited for the rougher purposes. It serves as a cheap and very accessible source of supply.

Most of the sandstone is micaceous, and much of it is arkosic. Most of it is from fine to medium grain in texture, but part of it is coarse and conglomeratic. A part of it is friable and disintegrates readily to a fine sand. When such exposures are windswept the surface of the exposure is often white or yellowish white in color. A part of the sandstone is of neutral gray or bluish gray color, and very massive. The neutral gray sandstone is always resistant, but the yellowish white sandstones are more friable and become resistant after the evaporation of the quarry

water. Some of these were used as curbing in Louisa fifty-five years ago, and are still quite well preserved.

The Mahoning sandstone is quite well exposed along the Big Sandy River. It has been used by the Norfolk and Western Railroad along Tug Fork, and by the Chesapeake & Ohio Railroad on Levisa Fork. The Pottsville formation contains many merchantable sandstones, and some of these have been used in construction work around Louisa, and by the railroad mentioned above. These sandstones have proved valuable.

There have been at least five quarries opened in Lawrence County, and possibly more.

(1) The Snyder Brothers quarry is situated three-fourths of a mile west of Louisa. The stone is massive, of dark bluish gray color, and resistant. The United States government secured the stone for the lock and dam at Louisa from this quarry.

(2) The Saltpeter quarry is situated at Saltpeter, West Virginia, 4 miles south of Louisa, but according to Colonel Jay H. Northrup, the stone for the lock and dam on Tug Fork at Saltpeter came from both sides of Tug Fork.

(3) The Chapman quarry. This quarry is located at Chapman, 8 miles south of Louisa, on Levisa Fork. The stone for the lock and dam at Chapman came from this quarry.

(4) This quarry was situated within the corporate limits of Louisa. It furnished the bluish gray, massive sandstone for street work in Louisa. The whitish or yellowish white sandstone used so largely in Louisa for curbing came from the same quarry.

(5) A bluish gray sandstone is reported to have been quarried just north of Kise station along the Chesapeake & Ohio Railroad on Levisa Fork, about midway between Richardson and Chapman. The beds are from 40 to 50 feet in thickness, and massive road building stone can here be secured in large quantities.

At Buchanan, 1 mile south of Louisa, on the farm of Mrs. Stump, there occur many bluffs of a yellowish white sandstone, with beds from 25 to 30 feet in thickness. According to C. J. Lawrence of Louisa, while drilling a well one-third mile south of Buchanan 70 feet of this sandstone was encountered.

(6) A sandstone higher than the Mahoning has been quarried for local purposes on Whites Creek near Egypt.

(7) At station 66 on the Mayo Trail 1½ miles south of Louisa a quarry has been opened in the buff sandstone for the abutments of bridges. A quarry face 150 feet in length, 20 feet in height, can be obtained here. The overburden varies from 1 to 3 feet. The stone will not meet State requirements for base course. The quarry is owned by William Adams.

(8) This quarry is at station 136, 2¾ miles south of Louisa. The haul to the point desired to use the stone would be about 40 rods. The stone is in fact yellowish white in color, and in part, brown in color. It is much harder than the stone in the Adams quarry.

(9) This quarry possibility is at station 153, 3½ miles south of Louisa, on land of C. P. Shannon. The sandstone is yellowish brown in color.

(10) This quarry is at station 440, 9½ miles south of Louisa. This sandstone is fine grained, reddish brown, banded, micaceous, schistose and breaks with an angular fracture. It is almost, if not quite, a quartz schist. A quarry with length of working face 200 feet can easily be opened. It is regarded as a good road building stone.

(11) This quarry possibility is at station 573, 11½ miles south of Louisa, and ½ mile toward Louisa from the mouth of Georges Creek. The stone is a very hard, bluish gray, micaceous, thick bedded sandstone if not a true quartzite. This outcrop was sampled and tested. The water absorbed in 24 hours was 1 part in 162. The per cent of wear was 3.5. The stone meets specifications and is considered very good.

(12) This quarry possibility is at station 781, 4 miles north of Louisa. The top layers of sandstone are yellowish white to brown in color while the lower layers are bluish gray. The stone is too soft for good road work.

(13) This quarry is at station 732, 5 miles north of Louisa. A working face 200 feet in length and 15 feet in height is obtainable. The stone is yellowish white in color and has been sampled for the State by F. A. Shobe, resident engineer.

(14) This quarry possibility is at station 529, 9½ miles north of Louisa. It is on the east side of the Mayo Trail and some 10 rods from the bridge over Cat Creek. The rock is a calcitic sandstone with the calcium carbonate well crystallized

and showing good cleavages. A quarry can be opened here 500 feet or more in length and width 50 to 75 feet in height of working face. Much of the outcrop carries no overburden and the stone should meet State requirements. The supply of stone is inexhaustible.

(15) This quarry is at station 413. It is a buff to reddish brown sandstone. It has been sampled by F. A. Shobe. The stone is regarded as weak from field observations only.

(16) This quarry possibility is at station 316 and only a few rods from the post office at Vessie. The stone is a drab colored limestone which appears on both sides of the Mayo Trail. A quarry can be opened from 100 to 200 feet in length and with 10 to 15 feet in height of working face. If the quarry is judiciously opened and operated it should furnish good limestone in abundance for use as surfacing the Mayo Trail.

Thin beds of limestone are reported to exist on Bolts Fork, Garner Fork, and Laurel Creek. Possible beds of merchantable thickness may be found in these calcitic rocks.

The peridotite dikes on Georges Creek in the southern part of the county are too small or narrow for practical road use.

Lee County.

The terranes in the eastern part of Lee County are all members of the Pennsylvanian system, while those in the western part of the county are in part Mississippian. There are four active quarries within the county.

(1) This quarry is situated at Yellow Rock on a branch of the Louisville & Nashville Railroad between Irvine, the county seat of Estill County, and Beattyville, the county seat of Lee County. The quarry is owned by Boggs and Burnham of Richmond. The quarry is quite large and produces excellent stone for local use.

(2) This quarry is situated at Willow, some 4 miles west of Beattyville. The stone is used for culverts, bridges, railroad ballast and road work. The output is about 1,000 tons per day.

(3) This quarry is on Contrary Creek a few miles south west of Beattyville. It is one of the best road building rocks of the State.

(4) Government Quarry. This quarry is on the opposite side of the river from the Yellow Rock quarry. The stone has been quarried by the United States government, and used in construction work along the Kentucky River.

Leslie County.

The outcrops of Leslie County are prevailingly sandstones. It is not known to the author that any quarries have been opened up within the county.

Letcher County.

The terranes of Letcher County are essentially sandstone. One exception is found in the cherty limestones along the Pine Mountain fault. A large quarry is opened at Jenkins near the little artificial lake of the Consolidation Coal Co. It is the Mississippian limestone.

Lewis County.

The terranes of Lewis County comprise both sandstones and limestones. The sandstones are mostly fine grained, thick bedded, argillaceous and range in color from buff to blue. 16 quarries were located in this county. A part are in the limestone and a part in the sandstone.

(1) The City Quarry. This quarry is located within the city limits of Vanceburg and is one of the best in the county. It furnishes much of the stone for underpinnings, curbing and street work. The rock is limestone.

(2) Clarksburg Quarry. This quarry is situated 3 miles southwest of Vanceburg. It appeared inactive. The product is limestone.

(3) L. Love Quarry. This quarry is located 3½ miles west of Vanceburg at the mouth of Quicks Run. This represents an excellent road constructional stone. The stone used for the lock and dam at Vanceburg came from this quarry.

(4) Tolesboro Quarry. This quarry is situated 1½ miles west of Tolesboro. The quarry has furnished much excellent limestone for bridges, culverts and road work. The stone wears well.

(5) Concord Quarry. This quarry is located 2 miles south of Concord. It is in limestone and has furnished much limestone for local use.

(6) Carrs Quarry. This quarry is 5 miles south of Concord. It is on the border between the limestone and the sandstone. Its vertical face varies from 8 to 15 feet.

(7) Herron Hill Quarry. This quarry is 10 miles southwest of Vanceburg. It is also on the dividing line between the limestones and sandstones.

(8) Kinney Hill Quarry. This quarry is situated some 4 miles southwest of Vanceburg on the Kinniconick Railroad. It is in sandstone that works so easily that it has received the name freestone. The individual beds vary from 1 to 2 feet in thickness. This stone has been used extensively.

(9) Slate Branch Quarry. This quarry is about 1 mile east of Vanceburg. It furnished much of the stone for curbing, sidewalks, etc., in Vanceburg. It is in sandstone.

(10) Dry Run Quarry. This quarry is located 1¼ miles south of Vanceburg. The stone is identical with that in quarry No. 9, and is used for the same purpose.

(11) Town Branch Quarry. This quarry is located 2 miles east of Vanceburg. It furnished the stone for the Union Soldiers' Monument at Vanceburg, which was the first one erected south of the Mason and Dixon line. The monument also carries the honor roll for Lewis County for the World War.

(12) Grassy Creek Quarry. This quarry is situated 4 miles south of Vanceburg. The individual beds of sandstone range from 20 to 26 inches in thickness.

(13) Quincy Quarry. This quarry is located 12 miles east of Vanceburg. The quarry is in sandstone.

(14) Valley Quarry. This quarry is situated in Valley, Kentucky, 7 miles south of Vanceburg. It is in sandstone.

(15) Alum Hill Quarry. This quarry is located on Alum Hill, only one-fourth of a mile from the courthouse. The county jail was constructed with stone from this quarry. It is in sandstone.

(16) There is a limestone quarry at Garrison on the Kinniconick Branch of the Chesapeake & Ohio Railroad which was

opened in 1881, and it has been in continuous operation since that date.

Magoffin County.

The terranes of Magoffin County are prevailingly sandstones. Four different horizons of sandstone beds occur around Salyersville. Some of these sandstones should furnish fairly satisfactory rock for the base course of a water bound macadam and for the coarse aggregate in concrete. One quarry in Pottsville sandstone is located at the south end of Salyersville near the Licking River.

Martin County.

The terranes of Martin County are essentially sandstones. Some of these sandstones should furnish material for the base course in highways and good stone for the railroads immediately to the east of Tug Fork. One quarry which has been operated recently in the construction of the new bank at Inez and is located one mile south of Inez on the Warfield road. It is in the Pottsville sandstone.

McCreary County.

The terranes of the eastern part of McCreary County are essentially sandstones. The western part of the county and the extreme northern part contain many outcrops of limestone.

These sandstones and limestones have furnished much stone for the Quincy and Cynthiana Railroad which traverses the center of the county in a north and south direction through Whitley City, the county seat.

Menifee County.

The terranes of the eastern part of Menifee County are sandstones. This group of sandstones sends many tongues of the Pennsylvanian rocks into the Mississippian formations. There are three belts of Lower Carboniferous rocks in the county.

(1) This exposure is along the western border of the county.

(2) This one lies along the Licking drainage to the north.

(3) This exposure falls along the Red River drainage on the south.

Frenchburg, the county seat of Menifee County, is reached by a spur of the railroad from Mt. Sterling. Along the highway between Frenchburg and Rothwell there is exposed 72 feet of Lower Carboniferous limestone underlaid by the Waverlian series. This limestone has been used extensively for local purposes, culverts, bridges and railroad work.

Morgan County.

The conglomerate sandstones in this county attain a maximum thickness of approximately 200 feet. These are well shown near the mouth of Greasy Creek, west of the town of Licking River. The outcrops are more or less massive, and should furnish good road building material.

The sub-carboniferous limestone which rests upon the Waverlian formations, without any considerable thickness of transition rocks, has an average thickness of about 50 feet. In the Licking Valley in the northwestern part of the county the Waverlian formations attain a thickness of approximately 200 feet. These are essentially sandstones and shales. The limestones contain both the dark gray and the light gray oolitic types. They are non-dolomitic, practically free from iron, the combined ferrous and feric oxide reaching only 0.32 per cent. The calcium carbonate content reaches 91.60 per cent, clayey matter is practically absent, and the silica content reaches 5.90 per cent. These rocks are therefore siliceous, oolitic limestones, that would make a most excellent road building stone.

Another type of the limestone in Morgan County is light gray and crystalline, with an irregular fracture. Its calcium carbonate content reaches 97.40 per cent. It is non-dolomitic, free from iron and susceptible of a good polish.

Owsley County.

The terranes of Owsley County are essentially sandstones. No railroads penetrate the county and no quarries are known to exist within the county.

Perry County.

The terranes of Perry County are sandstones. Some of these are particularly hard, massive and durable. A good exposure of these hard sandstones can be seen near the mouth of Leatherwood Creek. The first three quarries listed below are all fine to medium grained, drab in color and pass the State specifications for base courses.

1. This quarry is at station 158, 3 miles north of Hazard.
2. This quarry is 1 mile east of Hazard on the Lothair highway.
3. This quarry is at Jeff on property owned by C. C. Hall. It is east of Hazard.
4. This quarry is ½ mile north of Hazard. The stone is used in masonry construction.

Pike County.

The terranes of Pike County are all situated in the Penn-

6. QUARRY IN NEUTRAL GRAY SANDSTONE.
This quarry shows the thickness and rift of individual beds of sandstone, Pikeville, Pike County, Ky.

sylvanian system, save a narrow strip in the extreme southwestern part of the county, where the Pine Mountain fault has brought the Mississippian limestone into view. This narrow belt of St. Louis limestone terminates at Elkhorn City. The commercial stones, therefore, of Pike County are sandstones.

1. Thomas Hoffman Quarry. This quarry is situated on

7. THICK BEDDED SANDSTONE
This sandstone is overlaid and underlaid by shales near end of bridge over Levisa Fork, Pikeville, Pike County, Ky.

the east side of Levisa Fork, within the city limits. A quarry face of 1,000 feet could easily be opened. The beds range from 15 to 18 feet in thickness. The stone has been used for bridges, culverts, curbing and paving. The rock is a faintly bluish gray, fine grained, micaceous, and slightly arkosic sandstone. It has perfect rift and grain, hammers white, and works easily.

2. The Oscar Love quarry is also located on the east side

of Levisa Fork. It is understood to be a part of the same bluff with the same characteristics of the stone as have been cited for No. 1.

3. This quarry is some 4 miles east of Pikeville on the county road to Williamson, West Virginia. In the construction

8. QUARRY IN GOOD SANDSTONE.
This quarry is on the Pikeville-Williamson Pike, Pike County, Ky.

of this road during the past two years much stone has been obtained here for bridges, culverts, and general road work. The stone is very massive, thick bedded, micaceous, arkosic, of bluish gray color, and well suited for road work.

4. T. J. Williamson Quarry. This quarry is situated at the south end of the main paved street, close to the city line. in what is known as Happy Hollow. It is also known as the Happy Hollow Quarry. The stone is of neutral gray color, fine grained, micaceous, and works easily. This quarry has furnished the stone for much foundation work, retaining walls, etc.

5. This quarry is situated 1 mile north of Pikeville and

about 25 rods west of the Chesapeake & Ohio Railroad. The stone is of neutral gray color, fine grained, micaceous, and has been used largely for curbing and paving the streets of the northern part of Pikeville.

6. This quarry is situated from 1½ to 2 miles north of Pikeville along the Chesapeake & Ohio Railroad, where stone was reported to have been quarried for the construction of the railroad. The stone is of bluish gray color, fine to medium grained, massive, compact, with good rift and grain. The quarry is inactive.

The bluff in which this inactive quarry is located extends in a northerly direction to Cedar Creek. A quarry could be opened with a 50 foot vertical face, extending hundreds of feet in length and with supply unlimited. The evidence is that this massive bluish gray sandstone would pass the State requirements for base course and the coarse aggregate for concrete. It is only a few rods from the proposed bridge on the Mayo Trail over the Levisa River.

7. The Belknap Coal and Rock Company operates a small quarry ¼ mile northwest of Pikeville on the Pikeville-Williamson Road. The stone is now being used in paving the streets of Pikeville.

8. Helvy Gap Quarry. This quarry is situated 2 miles west of Pikeville on the Pikeville-Williamson Road. The stone is a hard bluish gray sandstone and it is used in road construction.

9. This quarry possibility is located on the crest of the divide, 3 miles west of Pikeville on the Pikeville-Williamson road. The stone is yellowish brown to greenish white in color and the beds are very massive. A quarry could be opened easily with 100 feet length and 40 feet height of working face.

10. This quarry is situated 4 miles west from Pikeville on the same road. The stone is a massive neutral gray to bluish gray sandstone. A quarry can be obtained with 100 feet length and 50 feet height of working face, and adequate supply. It is about 200 feet lower in the geologic column than No. 9. There seems to be but little overburden. The stone meets the State rquirements for base course. The percentage of wear is 5.4.

11. This quarry is on Raccoon Creek 9 miles west of Pikeville on the same road. The stone is being quarried for the new bridge over Raccoon Creek.

12. This quarry is situated 10 miles west of Pikeville and

9. SANDSTONE QUARRY.
This quarry is in bluish gray and massive sandstone, 20 rods north of the C. & O. R. R. Station, Marrowbone, Pike County, Ky.

the Pikeville-Williamson road, and a few rods beyond the bridge over Johns Creek. The stone is a little finer grained than No. 10 and a little more micaceous. It is about 200 feet lower in altitude and is overlaid by a coal seam. The supply is ample. The stone was sampled and passed the State requirements for base course. The percentage of wear was 7.3.

13. This quarry is at Marrowbone 16 miles south of Pikeville and 8 miles north of Elkhorn City. It is furthermore 6 miles south of Shelby and within 40 rods of the Chesapeake & Ohio Railroad at Marrowbone. It is also within 20 rods of the south end of the bridge over the Levisa Fork of the Big Sandy. The stone is compact, bluish gray and micaceous. A 100 foot length of working face could be secured. The thickness of the

sandstone is unknown but it is at least 15 feet. It is overlain by beds of shale and sandstone 20 feet in thickness. The rock from this quarry was used as the coarse aggregate in concrete in the construction of the bridge over the Levisa Fork. It meets the State requirements for base course. Its percentage of wear is 4.6.

14. David R. Coleman Quarry. This quarry is situated only a few rods north of the Regina P. O. along the west side of the Chesapeake & Ohio Railroad. The stone is identical with No. 13 and was used somewhat in the same construction work.

15. This quarry is at Yeager, 3 miles south of Shelby at station 551. 10,000 yards of bluish gray micaceous sandstone has been quarried for ballast and road construction. The stone is the same as that at Marrowbone. It meets State requirements for base course.

16. This quarry is near the mouth of Shelby Creek. It has been used in bridge construction and meets the State requirements.

Powell County.

The terranes of Powell County are widely varied in composition and age There is but one quarry known to exist in the county. This is on the Louisville and Nashville Railroad about 5 miles from Glencairn. The quarry is one of the largest in Eastern Kentucky. The length of the quarry is 200 feet or more. The height of the working face is approximately 100 feet. The quarry contains excellent stone.

Pulaski County.

The quarries are more numerous in this county than in any other county in Eastern Kentucky, although none of them even approximate in size to the quarry of J. W. Sparks in Rockcastle County. Twenty-two quarries have been listed; most of them are small and some are inactive. They are all in the limestone series.

1. Thomas Meece Quarry. This quarry is located on the southwest side of Reservoir Knob, just outside of the city limits of Somerset. The quarry is of average dimensions, but a quarry with a working face of several hundred feet in length, and more

than 50 feet in height of face, could easily be opened. The present quarry is 150 feet in length, 50 feet in breadth, and with a working face of 30 feet. There is a rock crusher at this quarry, and the stone is all used for road purposes.

The rock in the upper half of the quarry is mineralogically and commercially a marble, for it is completely recrystallized with the calcite showing perfect rhombohedral cleavage. It is also susceptible of a good polish. It is traversed by numerous zigzag lines of dark grayish black color, which stand out in striking contrast with the remainder of the polished surface. The marble itself is of very light brown to medium gray color, with tints of pink.

There occurs also in this quarry a white to grayish white, microcrystalline limestone. The beds are massive, fine grained, and hand samples break out with a conchoidal fracture. This bed would also make a good road building stone.

2. The Cundiff Quarry. This quarry is owned by Mrs. Cundiff, and is situated on the north side of Reservoir Knob. The beds are massive and of a bluish gray color. This quarry is inactive, although it has furnished considerable stone for constructional work, especially for the Southern Railroad System.

3. This quarry is situated on the Stanford pike, some 2 miles out from Somerset. The stone is of buff color.

4. Some 5 or 6 miles east of Somerset on the Grundy pike there are several small quarries, all of which are listed as No. 4. The beds are massive and the stone is of medium gray color.

5. Jacob Mayfield Quarry. This quarry is situated 3 miles beyond Shopville and on Short Creek. The stone is massive and of medium gray color.

6. Ed. Thurman Quarry. This quarry is located 1½ miles west of Somerset. The beds are massive. The limestone is white to grayish white in color, and is identical with the white limestone of Reservoir Knob.

7. Norwood Quarry. This quarry is at Norwood, some 4 miles north of Somerset. It is owned by the Sunigan heirs. This quarry has a length of 300 feet, a breadth of 200 feet, and a working face of 80 feet. It is an excellent quarry. The stone is a dark gray, crystalline marble, closely resembling the Danville marble.

8. J. S. Kendrick Quarry. This quarry is situated 2 miles east of Somerset, and has been in operation intermittently for over 50 years. Two distinct types of stone occur here. One is of medium gray color, and the other is grayish white.

9. B. G. Vaughn Quarry. This quarry is about 1 mile east of Somerset. It has furnished much stone for foundation and veneering in Somerset.

10. J. H. Gibson Quarry. This quarry is situated ½ mile southeast of Somerset, and the stone has been used for foundation work in general.

11. Taylor-Hudson Quarry. This quarry is about 1 mile east of Somerset. The stone is used for foundation work. This quarry requires no stripping.

12. Scott Quarry. This quarry is situated ½ mile northeast of Somerset. The stone is white or grayish white in color and has been used for building purposes, and also burned into white lime for both constructional and agricultural use.

13. Beecher Smith Quarry. This quarry is located some two miles due east of Somerset. The stone is white or grayish white in color and has been used for building purposes, and also burned into white lime for both constructional and agricultural use.

14. Chas. Evans Quarry. This quarry is located on Holtzclaw Knob, 5 miles north of Somerset. It is a dark gray crystalline marble like that in the Norwood Quarry.

15. J. M. Richardson Quarry. This quarry is just west of Somerset. The beds are about 4 feet in thickness. The stone is a very dark gray color and crystalline.

16. William Denham Quarry. This quarry is situated on the southwest side of Somerset.

17. Hannah Denham Quarry. This quarry is located 2½ miles due west of Somerset.

18. The Burton Quarry. This quarry is about 8 miles west of Somerset.

19. William Lee Quarry. This quarry is about 8½ miles west of Somerset.

20. Samuel Higgins Quarry. This quarry is some 2 miles east of Somerset. It is a fine grained, bluish gray limestone.

21. Fletcher Grove Quarry. This quarry is located at Cedar Grove some 4½ miles south of Somerset. It has been in operation for many years.

22. Lincoln Denton Quarry. This quarry is within the city limits.

Rockcastle County.

Limestones, marbles and sandstones are well represented in Rockcastle County. The commercial marbles receive a good polish and are capable of wide industrial application. The sandstones are fine grained, even textured, and their reputation could be made national.

1. W. J. Sparks Company Quarry. This quarry is situated ¾ of a mile northwest of Mt. Vernon. The quarry was opened in 1908. Four acres of stone have been removed. The present dimensions of the quarry are 1,000 feet in length, 300 feet in breadth, and 110 feet in height of working face. As the quarry is carried back further into the hill it will have a working depth of 150 feet. The product is all limestone and used by the railroads. A large crusher prepares the stone for shipment.

Two distinct types of calcareous rocks exist in this quarry. One is a white crystalline oolitic limestone, limestone because not completely calcitized, and the other is a massive, compact medium gray microcrystalline limestone. In the former, many of the oolites are still visible, and the crystals of calcite make up the rest of the rock. It is fine grained, even textured, with perfect rift and grain, and susceptible of a very good polish. The hard, massive, compact phase breaks with a conchoidal fracture, and is best suited for bridges, culverts, retaining walls, curbing, street and railroad work. The mixed product from the quarry runs from 96 to 98 per cent calcium carbonate.

2. Sparks Quarry Plant. This plant is situated at Sparks, 3 miles south of Mt. Vernon. The stone possesses the same characteristics as given for No. 1. The quarry is 500 feet in length, 300 feet in breadth, and 142 feet in depth. The crusher has a capacity of 1,000 tons per day.

3. Fred Kreuger Quarry. This quarry is within the city limits. It is in the white, oolitic crystalline limestone which at this quarry runs about 99 per cent calcium carbonate. The entire product is put into lime for agricultural purposes.

4. This quarry is situated 4 miles southeast of Mt. Vernon on the Queen & Crescent Route of the Southern Railway System. The quarry is in limestone.

5. Mullins Quarry. This quarry is situated at Mullins, 8

10 CRUSHING PLANT.
Crusher of the W. J. Sparks Company, Mt. Vernon, Rockcastle County, Ky

miles due east of Mt. Vernon, and 3/4 of a mile north of Sink Junction on the Kentucky Division and Lebanon Branch of the Louisville & Nashville Railroad. The quarry is entirely in limestones possessing the same characteristics as the W. J. Sparks Company quarry. This quarry was opened in 1897.

6. Rockcastle Lime and Cement Plant. This quarry and $200,000 plant is situated at Pine Hill, 5½ miles southwest of Mt. Vernon. The limestones are gray in color, fine grained, some of them crystalline, and could be used for building purposes. The bottom portion of the limestone carries 94.28 per cent calcium carbonate and 2.00 per cent silica. The central portion carries 93.21 per cent calcium carbonate and 2.85 per cent silica. The upper portion carries 93.48 per cent calcium carbonate and 2.40 per cent silica. The rock is therefore a siliceous limestone.

7. Local Quarries. There are several of these around Mt.

Vernon in the limestone series which are quarried intermittently to obtain stone for retaining walls, foundations and curbing.

8. Langford Quarry. This quarry is situated 4 miles north of Mt. Vernon at Langford, on the Kentucky Division of the Louisville & Nashville Railroad. The quarry is owned by the Kentucky Freestone Company at Rowan County, and is known quite widely throughout the State as the Rockcastle Freestone Quarry. The quarry was opened in 1896. The rock is an argillaceous sandstone, of drab color, fine grain, even texture. The stone splits freely in all directions. The individual beds vary from 3 to 5 feet in thickness. The stone is remarkably free from iron, and weathers uniformly. It should meet the State requirements for base course.

9. Wildie Quarry. This quarry is located at Wildie on the Louisville & Nashville Railroad. The product is known as the Rockcastle freestone, with the same general characteristics as the stone in the Langford quarry.

10. There is a small quarry near Brush Creek reported to be in the freestone, and not visited.

11. There is a quarry about 1 mile north of Limestone on the west side of the Louisville & Nashville Railroad. This sandstone is reported to be very brittle and not suited for road construction.

12. According to J. R. Drummy, Field Testing Engineer, limestones occur along the Rockcastle River banks about 2 miles from the village of Livingston. There is not a large amount of stone at this site for road construction. The stone meets the State requirements. Its percentage of wear is 5.8.

Rowan County.

The road building rocks of Rowan County are argillaceous sandstones of gray, or bluish gray color. They are very fine grained, and even textured. They split freely in all directions, hence the name Rowan County freestone. The lift is parallel with the quarry floor, the rift is north and south, and the grain is east and west. The beds pitch at a low angle to the east just enough for drainage. The stone cuts to a sharp edge and hammers a grayish white.

1. Rowan County Freestone Company. This quarry is owned by Dr. Howard Van Antwerp. The quarry is situated at Farmer. The quarry is some 400 feet in length, 100 feet in breadth, and 35 feet in height of working face. The beds lie in a horizontal position, separated from each other by thin layers of blue shale, which is very soft. This fact aids materially in quarrying the sandstone. The overburden of soil and some waste rock are thrown against the quarry front, so that the quarry is not in full view from Farmer Station.

The thickness of the individual beds reading downward, is approximately as follows:

No. 1, 12 inches, building stone
No. 2, 12 inches, building stone
No. 3, 18 inches, road building work
No. 4, 18 inches, building stone
No. 5, 14 inches, building stone
No. 6, 30 inches, building stone
No. 7, 21 inches, building stone
No. 8, 27 inches, building stone
No. 9, 12 inches, building stone

The last layer is very hard, and has never been removed. It is used as the quarry floor to a very good advantage. The quarried blocks are shipped by tram to a siding at the foot of the bluff. The mill for sawing the blocks of stone, dimension size, was burned May 14, 1921, and a new mill has just been constructed at the old site.

In breaking the stone into suitable blocks for road foundations a pear-shaped cast iron ball weighing 2,200 pounds drops from 5 to 15 feet, according to the thickness of the blocks to be broken. In the construction of a permanent road in Farmer a 10-inch bed of this broken stone was used, covered by 4 inches of crushed limestone, and top-dressed with 2 inches of Kentucky rock asphalt. The total output of this quarry could easily reach 1,000,000 cu. ft. of stone per annum. The same Buena Vista sandstone stretches southward into the hills for some three or four miles, and in places the individual beds are reported to be 40 inches in thickness.

2. Bluegrass Quarries Company. This quarry is owned and operated by C. S. Brown of Huntington, West Virginia. The

quarries are situated some ¾ of a mile southwest of Rockville Station. The shipping point is Freestone and the post office Bluestone. The quarry is perhaps a little smaller than that of the Rowan County Freestone Company, but the overburden is not quite so heavy. At the quarry there are 13 beds of bluish gray, fine grained sandstone, with aproximately the following thickness, reading downward:

No. 1, 5 inches, road stone
No. 2, 12 inches, building stone
No. 3, 11 inches, building stone
No. 4, 15 inches, building stone, buff colored
No. 5, 6 inches, building stone, steel gray
No. 6, 10 inches, building stone
No. 7, 18 inches, building stone, best grade of quarry
No. 8, 18 inches, building stone
No. 9, 8 inches, road stone
No. 10, 30 inches, building stone
No. 11, 22 inches, building stone
No. 12, 32 inches, building stone
No. 13, 14 inches, building stone, not quarried.

This bottom layer is used as a quarry floor. All the beds make excellent building stone, save Nos. 1 and 9. These, on account of an iron content, are better suited for road construction than for building purposes.

The Bluegrass Quarries Company has a mill at the foot of the bluff, equipped with gangs of saws for cutting the stone into dimension sizes before shipment for constructional work. The stone is brought to the mill by gravity roads. The evenness of the layers and the number of layers of different thicknesses give a product of most any desired thickness with the least possible expense. The thin, soft, shaly layers between the different sandstone beds facilitate the quarrying of the stone.

3. Kentucky Bluestone Company, Inc. This quarry is located at Bluestone, on the Ashland-Louisville branch of the Chesapeake & Ohio Railroad. The quarry is in the same bluish gray to gray, fine grained, argillaceous sandstone of the Buena Vista formation. The beds here also are separated by thin layers of soft shale, which facilitate the quarrying. The stone is split with shims and wedges so that there is no waste of material from

fracture by explosives. The stone is shipped to the mill by a gravity road. The quarry is about ¼ of a mile west of the mill.

PHOTO BY W. R. JILLSON

11. ROCK ASPHALT BEDS IN OUTCROP.
These deposits occur near Big Clifty in Grayson County, Ky. They are the source of excellent road surfacing material.

The thicknesses of the individual beds of sandstone, reading from the top downward, are approximately a follows:

No. 1, 10 inches, building stone
No. 2, 12 inches, building stone
No. 3, 9 inches, road stone
No. 4, 15 inches, building stone
No. 5, 9 inches, road stone
No. 6, 19 inches, building stone
No. 7, 17 inches, building stone
No. 8, 21 inches, road stone
No. 9, 12 inches, is used as the quarry floor.

Beneath this layer there are two other layers from 12 to 15 inches in thickness that are kept as a quarry reserve. Beneath this sandstone is the black Chattanooga shale of Devonian age.

The quarry is opened about 600 feet in length, with a

breadth of 200 feet, and vertical depth of some 30 feet. At least 5 acres of stone appear to have been removed. The quarry is fully capable of putting out more than 100,000 cu. ft. of stone per annum.

The company has a good mill with modern machinery for

12. BROKEN STONE ON 10-INCH ROAD BED.
Base course work on the Midland Trail, Farmer, Rowan, County, Ky. The stone came from the Van Antwerp Quarry, Farmer, Ky.

cutting the stone with gang saws, into dimension blocks, and dressing the stone as may be desired. The steel saws are fed with silica sand and water to aid in the cutting. About one half of the quarry output is sawed on two sides, and one-half is sawed on four sides.

The product from this quarry has been used extensively for bridge stone, sawed flagging stone, etc. With a judicious selection of the blocks, the stone weathers uniformly.

4. There is an opening in the same Buena Vista formation 7 miles north of Bluestone, where the beds attain a maximum thickness of 7 feet. This locality may be regarded as a sandstone reserve.

A considerable amount of the black Chattanooga shale was

used in grading the Midland Trail between the mills of the Kentucky Bluestone Company and the Bluegrass Quarries Company. The stone is regarded as too soft for road work.

5. This quarry is situated some 2,000 feet south of station 220 on the Midland Trail 4 miles east of Morehead. It is furthermore situated on the north side of the Chesapeake and Ohio Railroad and ¾ mile west of Gates. It is on property owned by Floyd Hall. The quarry is about 100 feet above the ravine and the stone is brought down by gravity. The stone is a yellowish green, fine grained, slightly micaceous sandstone. The percentage of wear is 5.8 and therefore it meets the requirements of State specifications.

6. This quarry is 1,000 feet north of station 253+ on property of J. W. Waltz. It was sampled by L. S. Coburn, Resident Engineer, and considered very good.

7. This quarry is situated 1,000 feet south of station 335 on property of R. D. Hayes. It is east from Gates 1½ miles. The stone is of yellowish green hue containing lenses of bluish gray color. It is practically identical with No. 5, and therefore a good road metal.

Wayne County.

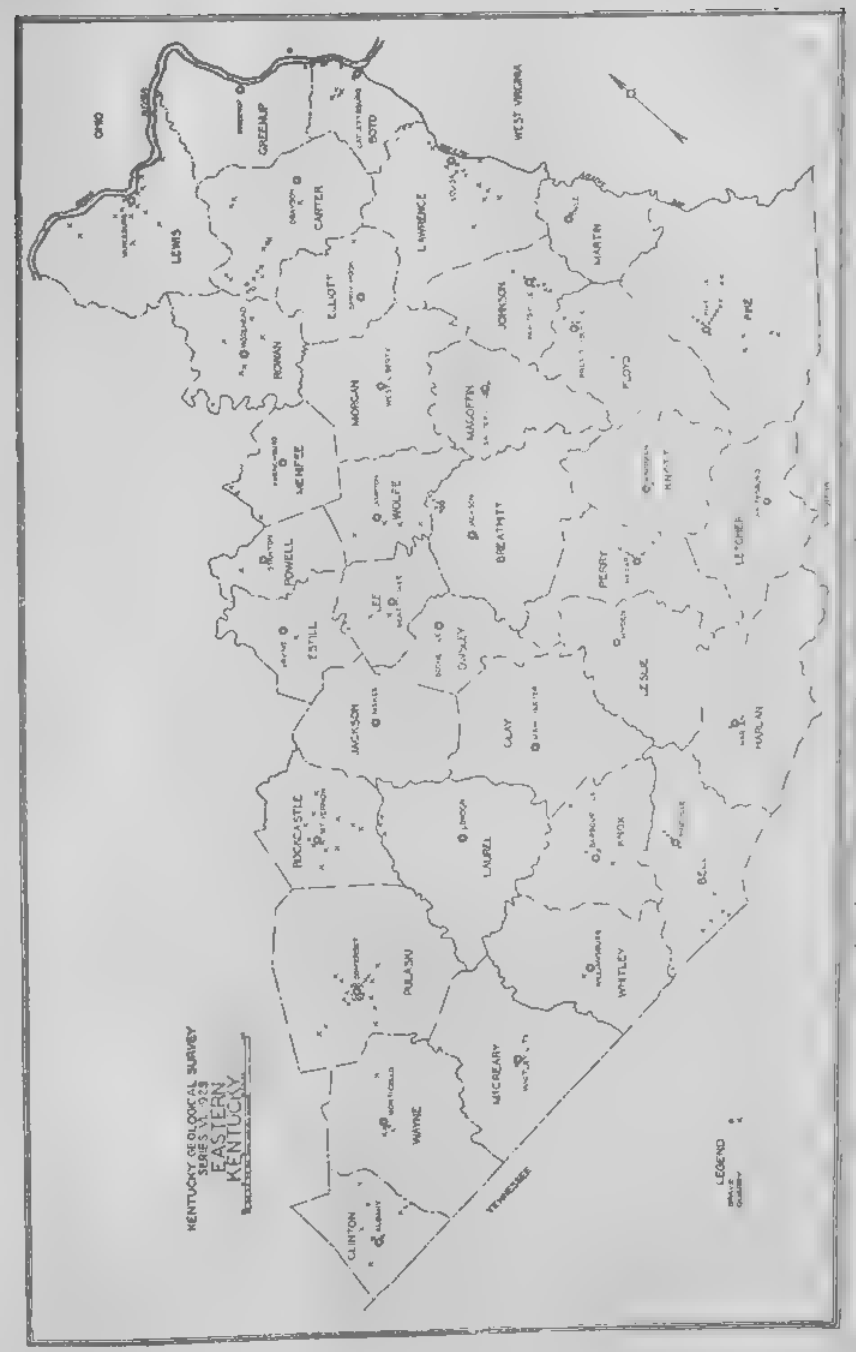
The terranes of Wayne County comprise limestones, sandstones and shales. The quarries are all small and located in the limestone series.

1. Dr. William Cook Quarry. This quarry is situated just outside the city limits of Monticello, and a little to the southwest. It is furthermore just across the first small stream after leaving Monticello. The stone is of medium to dark gray color, fine grained, and should make an excellent road building stone.

2. County Jail Quarry. This quarry is on the same creek as No. 1, and not far from the Cook quarry. The stone has been used in bridges and curbing.

3. This quarry was reported to be a short distance south of Monticello, and the stone used for bridges and curbing.

4. This quarry is said to be near No. 3, and the stone used for the same purpose. The quarries are in limestone and very small.



5. At Mill Springs in Wayne County a limestone quarry furnished the stone to build the canal along the cliff.

Whitley County.

The terranes of Whitley County are sandstones, conglomerates, and limestones. Essentially the outcrops are sandstones, but the limestones appear in the southwestern part of the county where the Pine Mountain fault has brought the St. Louis limestone into view. This limestone should furnish much good road building material.

One quarry exists on a branch of the Louisville & Nashville Railroad 1 mile west of Williamsburg. The rock is a sandstone of reddish brown color. The working face is from 30 to 40 feet in height.

Wolfe County.

The terranes of Wolfe County are prevailingly sandstone. Many of them have too high a percentage of wear for road work. However, some are fine grained, hard, and meet the State requirements for road building purposes.

1. This quarry is in sandstone. The percentage of wear is 8.2.

2. This quarry is in sandstone. The percentage of wear is 10.5.

3. This quarry is on the John Duff farm 7 miles southeast of Stanton. The percentage of wear is 25.8.

4. This quarry is 4 miles west from Stanton. The percentage of wear 4.0. It therefore meets the State requirements.

EASTERN KENTUCKY

No. of County	Name of County	No. of Quarries in County
1	Bell	10
2	Boyd	9
3	Breathitt	7
4	Carter	14
5	Clay	0
6	Clinton	7
7	Elliott	1

No. of County	Name of County	No. of Quarries in County
8	Estill	1
9	Floyd	6
10	Greenup	1
11	Harlan	1
12	Jackson	0
13	Johnson	8
14	Knott	1
15	Knox	4
16	Laurel	3
17	Lawrence	16
18	Lee	4
19	Leslie	0
20	Letcher	1
21	Lewis	15
22	Magoffin	1
23	Martin	1
24	McCreary	1
25	Menifee	1
26	Morgan	0
27	Owsley	0
28	Perry	4
29	Pike	16
30	Powell	1
31	Pulaski	22
32	Rockcastle	12
33	Rowan	7
34	Wayne	5
35	Whitley	2
36	Wolfe	4
	Total number of quarries	186

CHAPTER VI.

CENTRAL KENTUCKY OR BLUEGRASS SECTION.

The Bluegrass section of north central Kentucky embraces more counties than any other distinct geographic province of the State. This chapter includes the counties affected by the Cincinnati Arch in its southern extension into Kentucky and the knobs that are adjacent thereto on the south and the southwest. The terranes are prevailingly limestone.

Anderson County.

The road building rocks of this county are all limestones. The Tyrone formation is the best known and the most widely utilized.

1. Tyrone Quarry. The village of Tyrone and the quarry are both on the west side of the Kentucky River, a few miles east of Lawrenceburg. The quarry is owned and operated by the Ripy Brothers. The quarry is approximately 300 feet in length, 250 feet in breadth, and 125 feet in depth. The heaviest individual bed is about 10 feet in thickness.

The Tyrone limestone is a very massive, compact, thick-bedded, white to dove colored stone. It breaks with a conchoidal fracture, and trims easily into ashlar blocks. Sawed faces are especially pleasing. The stone shows on its fractured surfaces facets of calcite, which have given to the rock the name "birdseye limestone." The perfect cleavage of these rhombs of calcite sparkle by reflected light like the eyes of a bird. It is well suited for curbing, bridges, culverts, paving, ballast, and road work.

2. W. M. Blackmore Quarry. This quarry is situated on the Frankfort-Lawrenceburg road near the Anderson-Franklin County lines. It is about 5 miles from Lawrenceburg. The stone is gray in color, thin-bedded, and regarded as a poor road metal.

3. Lewis McBrayer Quarry. This quarry is on the

Lawrenceburg and Nelson County road 3½ miles west of Lawrenceburg. A part of the stone in this quarry is coarsely crystallized, which tends to weaken its abrasive power. A part of it is fine-grained, compact, and brittle.

14. SECTION OF RIPY BROTHERS QUARRY.
This quarry is at Tyrone, Anderson County, Ky.

With the assistance of J. T. Madison, Office Engineer, this quarry was sampled and the percentage of wear was 7.2. It, therefore, failed the State requirements, save for base course. This quarry was later resampled by Mr. Madison; four different types of limestone were included in the sample. The water absorbed in 24 hours was 1 part in 121. The percentage of wear 6.6. Therefore, it failed to meet State specifications, save for base course.

4. Lister Ganes Quarry. This quarry is on the Lawrenceburg-Tyrone road. The quarry opening is 350 feet by 150 feet by 20 feet. The stone has been used in road work and is considered good.

5. Frank Searcy Quarry. This quarry is 2½ miles east of Lawrenceburg on the Lawrenceburg-Tyrone road. The quarry has an active crusher, and the stone is used in road work.

6. Jim Cole Quarry. This quarry is ¼ mile due south

from the Blackmore quarry, but on the Alton-Frankfort pike. The stone is regarded as good.

15. CRUSHING PLANT OF THE RIPY BROTHERS.
This plant is at Tyrone Anderson County, Ky. It is one of the largest crushers in the State.

7. Butler-Saffel Distillery Quarry This quarry is on the Louisville-Crab Orchard pike, 1½ miles north of Lawrenceburg. The stone is dark gray in color, thin bedded, but extremely hard. The available supply of stone is small.

8. McCall Springs Quarry. This quarry is 3½ miles south of Lawrenceburg on the Louisville-Crab Orchard pike. The stone is thin-bedded, but the supply is ample.

Bath County.

The terranes of Bath County cover a much wider range of formations than is usually represented in a single county in Kentucky. Both limestones and sandstones are represented.

1. The limestones are of gray or bluish gray color, and have been quarried for local use not far to the west of Owingsville.

2. The Buena Vista sandstone of Mississippian are is represented at Caney Switch by 12 feet of fine grained, even textured, drab colored sandstone. The individual layers are sepa-

rated by thin beds of soft, bluish gray shale, which materially reduces the expense in quarrying. The stone works easily and is the same in its essential characteristic as the freestone of Rowan County. Its close proximity to the railroad is in its favor for shipping, but the stone would have to be transferred to the Chesapeake & Ohio Railroad at Salt Lick, which would add to the cost of production.

3. Buena Vista sandstones occur also around Olympian Springs, a few miles south of Olympia, but these are rather thin bedded, and their use would be local.

Boone County.

The terranes of Boone County are all in the Ordovician system and belong to the Cincinnatian series They are essentially thin bedded and shaly limestones, which are too friable for extensive use as road building stone. A single quarry exists near Burlington. The stone is used locally for underpinning, curbing, bridge construction, etc.

Bourbon County.

The quarries of Bourbon County, whether active or inactive, are all in limestone, more or less recrystallized. Some of them are sufficiently crystallized to be classed as marbles. Some of them receive a very good polish, and are well suited for constructional work, culverts, curbing, railroad ballast, and road work. They shade in color from pink to gray and light brown. They are of fine grain, even texture, and work easily. They hammer white, and often the contrast is strong between hammered and polished surfaces. They are sufficiently thick-bedded and persistent for large quarries to be opened. They are so near the Louisville & Nashville Railroad that the quarried products may be handled with the minimum cost.

1. Paris Quarry. This quarry is under the control of Bourbon County, and was also called the county quarry. It is situated within the city limits of Paris, and not more than one-half mile east of the courthouse. It is also on the bank of Stoner Creek. The quarry opening is 400 feet in length, 250 feet in breadth, with a vertical working face of 40 feet. There is a rotary rock crusher here with a capacity of 200 tons per day.

2. City Quarry. This quarry is situated one-fourth mile north of the courthouse on Seventh Street. It is also situated on Houston Creek. The quarry opening is approximately 500 feet in length, 250 feet in breadth, and 40 feet in depth. The rock crusher installed at this quarry has a capacity of 150 tons per day, and is of the jaw type. The stone is in every way similar to that in the Paris quarry.

3. North Middleton Quarry. This quarry is situated 11 miles southeast of Paris on the Mt. Sterling pike. Approximately one acre of rock has been stripped of its overburden and a rotary crusher installed, with a 200 ton capacity.

4. Cane Ridge Quarry. This quarry is situated 4 miles north of North Middleton and 7 miles east of Paris on the Paris-Maysville or Flat Rock pike. The quarry is 150 feet in length, 100 feet in breadth, with a working face 20 feet in height. The crusher has a daily capacity of 150 tons. The Cane Ridge stone lies in a horizontal position, and beds outcrop along the ridge for a distance of some 4 or 5 miles. It has been used extensively for foundations, bridge abutments, and curbing in North Middleton.

5. This is also a Cane Ridge quarry, and is situated between the North Middleton quarry and the Cane Ridge quarry.

6. Courthouse Quarry. This quarry is situated 1 mile east of Paris on the Maysville pike. The stone has been used quite extensively in Paris in foundations, retaining walls, etc.

7. Ruddles Mills Quarry. This is one of the oldest quarries in the county, and the village is one of the oldest in the State, for it is reported to have been settled soon after the arrival of Daniel Boone.

8. Wood Brothers Quarry. This quarry is situated on the Taylor farm, 1 mile northeast of Paris, but it is now abandoned.

9. and 10. A few miles north of Paris towards Cynthiana there are two small quarries in the same limestone as that around Paris.

Boyle County.

The limestones of Boyle County are often of light gray color, rather coarsely crystalline, and with fairly even texture. Some of them show large plates of calcite with perfect rhombohedral cleavage and cavities partially filled with perfect crystals of dog-toothed spar, a variety of calcite. The rock is called a limestone rather than a marble, because the voids are not completely filled with recrystallized calcite.

1. Taylor Brothers Quarry. This quarry is situated on the Stanford pike, 1½ miles south of Danville. The length of the quarry is approximately 300 feet, the breadth is about 250 feet, and the depth is 55 feet. The upper portions are of light gray color and somewhat coarsely crystallized, while the thick bedded, massive lower portions are of dark gray color and crystallized. The stone from this quarry is well suited for abutments, bridges, culverts, railroad balast and macadam.

2. Tevis and Ingram Quarry. This quarry is situated on the Lexington pike 2½ miles north of Danville. The stone is of bluish gray color and the quarry has been in operation for three years. The stone is used locally for road work. It is not quite so large a quarry as that described as No. 1.

3. This quarry is situated on the Lexington pike some 4 miles north of Danville. The stone is in part of bluish gray color and in part nearly white. The rift and grain are perfect. The stone is used for road work.

4. This quarry is only a short distance out from Danville, and is now inactive.

5. This quarry is 4½ miles west of Danville on the Perryville pike. The stone is bluish gray, and the height of the working face of the quarry is 20 feet.

6. This quarry is on the Perryville pike 6 miles west of Danville. The working face of the quarry is about 60 feet in height and the stone is used for road work.

7. This quarry is on the Lebanon pike about 5 miles southwest of Danville. The height of the quarry face is about 20 feet, and the stone is used for road construction.

8. This quarry is near Parksville, 7 miles southwest from Danville. The stone is used for macadam.

9. This quarry is between Danville and Junction City, and is now inactive.

10. W. J. Sparks Quarry. This quarry is at Parksville on the Louisville & Nashville Railroad. It is one of the largest and best quarries in the county.

Bracken County.

The limestones and shales of Bracken County are thin bedded, and can furnish limestones for local use only.

1. Foster Quarry. This small opening near Foster is in the Lexington limestone. The beds are thin and the stone medium to gray in color.

2. Brooksville Quarry. A small quarry near Brooksville has furnished stone for underpinning and curbing in Brooksville.

3. Bradford Quarry. This quarry is located at Bradford, a small station on the Chesapeake & Ohio Railroad west of Wellsburg. The stone which has been used locally is a dark gray limestone.

Bullitt County.

The terranes of Bullitt County comprise both limestones and sandstones. The sandstone is regarded as too soft for road work.

1. Shepherdsville Quarry. This quarry is near Shepherdsville. The stone is used locally, and is in the limestone.

2. There is a small opening near Belmont, Belmont Furnace, in a buff colored, fine grained sandstone. It is a friable sandstone, with clayey matter as the cementing material. It appears too soft and brittle for road constructional purposes. An analysis of the stone gave 94.75 per cent of silica and insoluble silicates. The same formation appears on the Knob at Bullitt's Lick.

3. Clermont Quarry. This quarry is situated near Clermont, a small station on the Louisville & Nashville Railroad. The quarry is several hundred feet in length, with a working face of some 20 feet in height. The stone is of light gray color.

4. Quarry Switch. This quarry is at Quarry Switch, on

the northeast side of the Louisville & Nashville Railroad. The quarry is in light gray limestone. This quarry can be made several hundred feet in length. It is so near the railroad that there is no cost in transporting the stone to the point of shipment.

5. Stites Quarry.This quarry is at Stites, a small station on the Louisville, Henderson & St. Louis Railroad, about 15 miles southwest of Louisville. The stone is used as railroad ballast.

Campbell County.

The terranes of Campbell County are essentially limestones. They are thin bedded, often with intercalated shale. They are of medium to dark gray color, and have been used locally in construction work, abutments, culverts, curbing, railroad ballast, and macadam.

1. I. J. Croxson Quarry. This quarry is situated 2 miles south of Newport on the Alexander pike. The stone is more massive than in the other quarries and makes a fairly satisfactory road building stone.

2. City Quarry. This quarry is situated on Grand Avenue about 1 mile southeast of Newport. The limestone at this quarry is somewhat shaly. There is a crusher at this quarry with a capacity of 150 tons daily.

3. Clifton Quarry. This quarry is 1½ miles south of Newport. The stone is all quarried by hand and used for foundation work.

4. New Richmond Quarry. This quarry is situated at New Richmond, some 20 miles southeast of Newport. It is a large quarry that has been used extensively for abutments, bridges, and railroad ballast by the Chesapeake & Ohio Railroad.

Carroll County

1. There is one large quarry in Carroll County. It is situated 1 mile northeast of Worthville, on the west side of the Louisville & Nashville Railroad. The quarry is in the face of a high bluff, with the base of the quarry several hundred feet above

the railroad. The quarry itself is about 400 feet in length, 100 feet in height of working face. The individual beds are quite massive. Some of them have thicknesses ranging from 4 to 6 feet. The stone is of light gray color, and weathers white. The most of the stone quarried has been used by the Louisville & Nashville Railroad for abutments, bridges, and railroad ballast.

2. Sam Wilson Quarry. This quarry is situated 3½ miles north of Campbellsburg on the Campbellsburg-Carrollton pike. It is also on Turners Station road, section 46A, ¼ mile from the pike. The limestone is grayish white in color, fossiliferous, fairly thick bedded, ample in supply, and nearly passes the State requirements. The water absorbed in 24 hours was 1 part in 123. The percentage of wear was 6.6.

3. This quarry prospect is at the four corners on Campbellsburg-Carrollton pike, 5½ miles from Carrollton. Carroll County owns one acre of this stone. The stone is practically identical with No. 2.

Clark County

The terranes of Clark County are prevailingly limestone. These limestones are thin bedded and inclined to be shaly. The fine grained, hard, compact beds make a good road metal. The thin shaly beds are unsatisfactory.

1. James Donahue Quarry. This quarry is owned and operated by James Donahue. The quarry is situated 1 mile south of Winchester. The stone is of dark gray color and of even texture. The quarry is small.

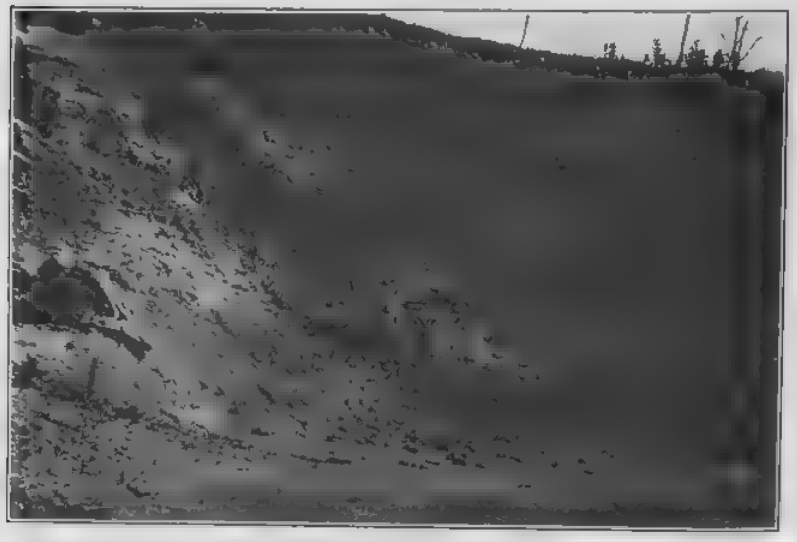
2. The Robinson Quarry. This quarry is situated 1½ miles southeast of Winchester. The stone is of medium gray color.

3. The Calmes Quarry. This quarry is situated about 2 miles south of Winchester on the Boonesboro pike. The stone is of medium gray color, and has been much used in foundation work, abutments, bridges and road work. It is regarded as a good road building stone.

4. Clark County Construction Company Quarry. This quarry is situated on Broadway, within the city limits. The

stone is very thin bedded, of dark gray color, and used in railroad construction.

5. Slusher Quarry. This quarry is on the Basin Springs pike, 7 miles west of Winchester. The stone is of light gray color, uniform texture, works easily, and is the best road building stone seen in the county. The stone is thin bedded, ranging



16. CITY QUARRY IN THIN BEDDED LIMESTONE
This quarry is at Winchester, Clark County, Ky.

from 7 to 10 inches. The quarry opening is approximately 100 feet in length, 50 feet in breadth, and 30 feet in height of working face.

6. S. H. Rutledge Quarry. This quarry is owned by Mr. S. H. Rutledge, Civil Engineer, Winchester, Ky. It is situated at the mouth of Goff's Branch of Dry Fork, where the Louisville & Nashville Railroad crosses Dry Fork near the village of Ruckerville. The stone is gray in color and well calcitized.

7. This quarry is about 1 mile east of Pine Grove, and is used for macadam.

8. This quarry is about 1 mile northeast of Winchester and is used for macadam.

9. This quarry is near the junction of the Skinners Mill

and Wades Mill roads, about 2 miles north by northeast of Winchester, and is used for macadam.

10. This quarry is 4 miles northeast of Winchester on the Wades Mill road, and is used for macadam.

17. ROCK CRUSHER AT CITY QUARRY.
This crusher is situated within the city limits of Winchester, Clark County, Ky.

11. This quarry is 6 miles northeast of Winchester near Wades Mill, and is used for macadam.

12. This quarry is at Skinners Mill, and is used for macadam.

13. This quarry is a little south of east of Winchester, about 5 miles from Winchester, and is used for macadam.

14 This quarry is about 2 miles southeast of Winchester, and is used for macadam.

15. This quarry is about 3 miles southeast of Winchester on the road to Ruckerville, and is used for macadam.

16. This quarry is on Four Mile Creek about 3 miles southeast of Winchester, and is used for macadam.

17. This quarry is about 1 mile southwest of Pine Grove Station on the Chesapeake & Ohio Railroad, and is used for macadam.

18. This quarry is about 2 miles southwest of Winchester on the road to Germantown, and is used for macadam.

18. LIMESTONE QUARRY ON JACKSON FERRY PIKE
This quarry is situated 4 miles southeast of Winchester, Clark County, Ky.

19. This is a large quarry situated just outside the city limits on the Louisville & Nashville Railroad. The stone is thin bedded and shaly.

20. Goshen Church Quarry A new, excellent and inexhaustible quarry has been opened this summer near the Goshen Church, 7 miles due east of Winchester. This stone is regarded as very good.

21. Van Meter Quarry. This quarry is situated 6 miles northwest of Winchester. The quarry is new. The stone is good. The supply is ample.

22. Jackson Ferry Quarry. This quarry is 4 miles southeast of Winchester. It represents a very good road building stone. The length of the quarry face is 100 feet. The breadth is 50 feet. The height is 20 feet, but may easily be made 40 feet.

There is but very little shale in this quarry. The limestone is gray in color, fine to medium grained, and in part recrystallized.

23. This is a new and excellent quarry situated some 8 miles southeast of Winchester. It is regarded by S. C. Boone, County Road Engineer, as the best road stone in the county. The supply of stone is ample.

24. John Martin Quarry. This quarry is on Lower Howards Creek, ½ mile from the Kentucky River, 10 miles southwest of Winchester, and near the Boonesboro road. The length of the working face is approximately 300 feet. The stone is the fine grained, dove colored, Tyrone or Kentucky marble. The supply is ample, for a quarry can be opened with 1 mile of working face with a height of 50 feet.

Fayette County.

The terranes of Fayette County are all limestones and marbles. These are widely distributed, and so judiciously used under the direction of W. H. Edwards, County Road Engineer, that this county has the best roads of any county in the State with the possible exception of Jefferson County.

The road building rocks in this county are:

(1) The fine grained, even textured, massive dolomitic Camp Nelson bed.

(2) The fine grained, even textured, buff colored dolomite, which represents the Oregon Formation.

(3) The massive, exceedingly fine grained, compact, dove colored Tyrone formation, which breaks with a conchoidal fracture.

(4) The grayish colored, granular, crystalline limestone of the Lexington series.

(5) The thicker beds of the gray or bluish gray Cynthiana limestone.

1. Clays Ferry Quarry. This quarry is situated about 13 miles southwest of Lexington near Clays Ferry. The quarry has been operated more or less intermittently for many years, and the stone shipped to Lexington. It carries much excellent road building stone.

2. Grimes Mill Quarry. This quarry is located at Grimes

Mill on Boones Creek, about 12 miles southwest of Lexington. It is in the Oregon and Tyrone formations.

3. This is a small quarry just east of the Richmond pike, a little south of where the Grimes Mill road branches to the south-

19. A. L. HAMILTON QUARRY ON TATES CREEK PIKE
This quarry is in limestone, 3½ miles south of Lexington, Fayette County, Ky. It produces fewer screenings than any other quarry in the county.

east from the Richmond pike. It is in the blue limestone, and is used in road construction

4. Jacks Creek Quarry. This quarry is situated on Jacks Creek pike, 12 miles south of Lexington. It is in the blue limestone and furnishes a good road metal.

5. Tates Creek Quarry. This quarry is on Tates Creek pike, just south of its intersection with Walnut Hill pike, 8 miles south of Lexington. It is a good road stone.

6. This quarry is on the Coletown and Kidville road, 9 miles south of Lexington. It furnishes good road metal.

7. Athens Quarry. This quarry is on the Boonesboro pike, 9 miles southeast of Lexington. It is a good road metal.

8. Boones Creek Quarry. This quarry is 1 mile southeast of Athens on Boones Creek.

9. Boonesboro Pike Quarry. This quarry is on the Boonesboro pike, 8 miles southwest of Lexington. It is a good road stone.

10. Cleveland Pike Quarry. This quarry is located on the Cleveland pike, 1 mile north of the Athens quarry. It is good road metal.

11. Armstrong Mill Quarry. This quarry is on the Armstrong Mill pike, 6 miles south of Lexington. It is a good road metal.

12. Tates Creek Pike Quarry. This quarry is on Tates Creek pike, 5 miles south of Lexington. It furnishes an excellent road stone.

13. Priectown Quarry. This quarry is situated at Pricetown on Todds pike, 6 miles southeast of Lexington. The stone is too soft and shaly for even road work. It wears away very rapidly under constant traffic.

14. Tates Creek Pike Quarry. This quarry is on Tates Creek pike, 3½ miles south of Lexington. This quarry furnishes but few screenings in the crushing of the stone for road construction. The screenings for top dressing the road in this vicinity are obtained from other crushers. The stone is the hardest of any found in the county, due to a greater interlocking of the calcite crystals. The thickest individual bed found in this quarry is 2 feet. This quarry is owned by A. L. Hamilton of Lexington, Kentucky. It is reported by W. H. Edwards as the best road metal in the county.

15. South Elkhorn Quarry. This quarry is on the Harrodsburg pike, 4 miles southeast of Lexington. It furnishes a good road metal.

16. Estell Quarry. This quarry is situated just a little north of the Winchester pike, 3 miles east by southeast of Lexington.

17. This quarry is on the Bryant Station and Chilesburg pike, some 6 miles east by southeast of Lexington. The screenings are exceptionally heavy, because the rock is too shaly for the best road work.

18. Avon Quarry. This quarry is on the Briar Hill pike, 7 miles east of Lexington. It furnishes a very good road metal.

19. Briar Hill Quarry. This quarry is on Briar Hill pike, 6 miles east of Lexington. The stone is excellent for road construction.

20. City Quarry. This quarry was situated within the

20. LIMESTONE QUARRY AT VILEY.
This quarry is situated 3 miles northwest of Lexington, Fayette County, Ky.

city limits of Lexington, just off from South Limestone Street, in the neighborhood of the large warehouse.

21. Jones Quarry. This quarry is on Spring and Pinard pike, near the Bluegrass Park, 7 miles west of Lexington. It furnishes good stone.

22. This quarry is one-half mile west of the city limits, but it is now abandoned. It has furnished good stone for local use.

23. Workhouse Quarry. This quarry is situated 1 mile west of the city limits, near the Louisville & Nashville Railroad.

It carries some very good stone, a part of which has been used in road work.

24. This quarry is situated near the Louisville & Nashville Branch of the Southern Railway System. It is too thin bedded, shaly and brittle to prove satisfactory in any work.

21. ROCK CRUSHER AT VILEY QUARRY.
This crusher is located 3 miles northwest of Lexington, Fayette County, Ky

25. Viley Quarry. This quarry is on the Louisville & Nashville Railroad 2½ miles northwest of Lexington. The stone is very good. This quarry has recently been purchased by Fayette County from the Louisville & Nashville Railroad. The length of the quarry is 400 feet. The height of the working face is 60 feet. The overburden is light. The rock crusher has a capacity of 300 tons per day. This quarry produces fewer screenings than any other quarry in the county, save the A. L. Hamilton quarry above noted.

26. This quarry is on the Louisville & Nashville Railroad, 3½ miles northwest of Lexington. The stone is good.

27. Headley Quarry. This quarry is situated on Russell

Cave pike, 1 mile northeast of Lexington. It furnishes handsome building stone for local use, and good road metal. The stone is gray in color, well crystallized, and susceptible of a handsome polish. Commercially, if not mineralogically, it is a marble. This quarry has been in continuous operation for many years.

28. Montrose Quarry. This quarry is at Montrose, 3 miles east of Lexington. The stone is very good.

29. Russellville Pike Quarry. This quarry is situated on the Russellville pike, 1½ miles northeast of Lexington. It furnishes a very good medium gray stone.

30. Haggin Quarry. This quarry is on the Haggin estate, about one half mile northwest of Muirs Station and about 6 miles northeast of Lexington. The stone in this quarry is good road stone.

31. Georgetown and Lexington Pike Quarry. This quarry is on the Georgetown and Lexington pike, 4½ miles north of Lexington. The stone is very good.

32. This quarry is on the Ironworks pike, 5 miles northwest of Lexington. The stone is used entirely for road work.

33. Daggin Quarry. This quarry is on Elkhorn Creek, 6 miles northeast of Lexington. The stone is good.

34. Huffman Mill Quarry. This quarry is on Huffman Mill pike, 6½ miles northeast of Lexington. The stone is good.

35. Greenwich Pike Quarry. This quarry is on Greenwich pike, 10 miles northeast of Lexington. This is an exceptionally good quarry for road metal.

36. Russell Cave Pike Quarry. This quarry is on Russell Cave pike, 10 miles northeast of Lexington. The stone is good.

37. Elkhorn Creek Quarry. This quarry is on Elkhorn Creek, about one-fourth of a mile east of the Huffman Mill road, and about 6 miles northeast of Lexington.

38. Harris Quarry. This quarry is on Elk Lick about 1 mile below Clays Ferry. The bed of the Oregon formation is 6 feet in thickness. An analysis of this bed gave 59.88 per cent calcium carbonate, and 37.05 per cent magnesium carbonate. This brings the rock well within the range of the dolomites.

Fleming County.

The rocks of Fleming County are widely varied in chemical composition, color, texture, degree of crystallization, and in the uses to which they are best adapted. A larger number of quarries have been opened in Fleming County than in almost any other county in the State.

1. County Quarry. This quarry is situated 1 mile east of the courthouse at Flemingsburg. It is in a dark gray limestone, which is used for road work.

2. City Quarry. This quarry was also called Cemetery quarry, for it is situated only a few rods from the cemetery gate The quarry opening is about 300 feet in length, 200 feet in breadth, and 20 feet in height of working face. The beds vary somewhat in thickness. The upper beds are comparatively thin. The lower beds are from 3 to 4 feet in thickness, massive, crystallized, and of dark gray color. The dark gray color is flecked with small white crystals of calcite. The stone works easily into ashlar blocks and is of uniform texture. It cuts to a sharp edge. It hammers white, and received a high polish The contrast is marked between the hammered and polished surfaces.

3. County Quarry. This quarry is situated on the Johnson pike, 1 mile northwest of Flemingsburg, and is used for macadam.

4. Station Quarry. This quarry is at the station of the Cincinnati, Flemingsburg & Southern Railroad. The stone is of light gray color, thick bedded, well crystallized and weathers white.

5. R. W. Meadows Quarry. This quarry is reached by going west from Flemingsburg 1 mile on the Mt. Sterling pike and then turning to the left and going ½ mile on the dirt road. The stone here is of light gray color and weathers white. It is a good road building stone.

6. Model Road Quarry. This quarry is 2½ miles northwest of Flemingsburg on the Fitch farm. It is a new quarry, but the stone is excellent for road work.

7. County Quarry. This quarry is on the Johnson pike,

4 miles northwest of Flemingsburg. The stone is regarded as one of the best in the county.

8. Fleming Creek Quarry. This quarry is situated 1 mile east of the courthouse. The quarry is small and inactive.

9. Red Sandstone Quarry. This quarry is situated 12 miles east of the courthouse. It has been used as macadam.

10. Hillsboro Quarry. This quarry is just east of Hillsboro and about 15 miles southeast of Flemingsburg. The stone is a bright red sandstone, and regarded good.

11. County Quarry. This quarry is 9½ miles east of the courthouse. It is also in the red sandstone and used as macadam.

12. County Quarry. This quarry is on Tupper Pike at Plummers Landing, 10 miles southeast of Felmingsburg. It is also called the Ferris Lane Quarry. The stone is used for macadam.

13. Maley Quarry. This quarry is 1 mile north of the courthouse. It is in limestone and inactive.

14. McIlvain Quarry. This quarry is situated near Cassidy Station, 2 miles southwest of Flemingsburg. The stone is of rich dark gray color, well crystallized, susceptbile of a high polish, and should be classified as a marble.

15. Kirby Quarry. This quarry is 4½ miles southwest of the courthouse on the Elizaville and Craintown pike.

16. Bridgeport Quarry. This quarry is situated 3 miles south of Elizaville, and is in limestone which would make a good road building stone.

17. Burns Quarry. This quarry is at Ewing, 7½ miles from Flemingsburg, and is a good road building stone

18 Stickrod Quarry. This quarry is 10 miles northwest of the courthouse. It is in very good limestone, but was abandoned on account of water. The water could be pumped out and the quarry reworked.

19. Andrews Quarry. This quarry is situated on the Flemingsburg and Upper Blue Lick pike, 3 miles west of the courthouse.

20. Grannis Quarry. This quarry is near No. 19, and is the same stone in all its essential characteristics.

21. Walker Quarry. This quarry is situated on the Maysville pike, 4 miles north of the county seat. It is now inactive.

22. Johnson and Kelly Quarry. This quarry is on the Johnson and Kelly pike, 4½ miles northwest of the courthouse.

23 Bradford Quarry. This quarry is on the Convict pike, 4 miles west of Flemingsburg.

24. Mt. Carmel Quarry. This quarry is situated on the Mt. Carmel pike, 5 miles northeast of Flemingsburg. It is in the bright red sandstone, and the stone has been used for macadam.

Franklin County.

The formations of Franklin County are all limestones, sometimes shaly in the upper layers of large quarries, but usually sufficiently thick bedded and massive for good road building stone. In fact, in some of the quarries blocks of any dimension desired can be obtained. They range in color from the white or nearly white Kentucky Marble, Tyrone, to a dark bluish gray limestone on the higher altitudes. Some of these are sufficiently crystallized to be classified as marbles. They are susceptible of a high polish.

1. J. B. Blanton Company Quarry. This quarry is situated within the city limits on the Kentucky River, and on the east side of Frankfort. The stone was quarried for the Old Capitol where the J. B. Blanton cement plant now stands. The quarry is 550 feet in length, 150 feet in breadth, and 100 feet in height of working face. The individual beds of this Kentucky Marble are about 6 feet in thickness, with a total thickness of 60 feet. A large part of the quarry product now enters into road work, cement products and concrete.

2. Workhouse Quarry. This quarry is situated on the north side of the city of Frankfort and within the city limits. It is owned and operated by the city. The length of the quarry face is approximately 300 feet, with breadth the same. The height of the working face is 172 feet.

The stone has been used for curbing on many streets in the city, and for paving blocks. A portion of the quarry product is now manufactured into cement products and concrete curbing. It is used in the construction of concrete houses and keeping

the paved streets of the city in repair. There is a large crusher at this quarry. The large crushed stone is 3 inches in diameter, the intermediate grade 2 inches in diameter, and the smallest size is screenings used in road dressing.

3. Frankfort Stone Company Quarry. This quarry is situated on the river road, just off Devil's Hollow pike. W. J. Hulette is the owner and operator. The quarry has been in continuous operation for 16 years, save in 1919 1920. The length of the quarry is 165 feet, the breadth of the quarry 100 feet, and the greatest height of the quarry face 165 feet. The thickness of the individual beds sometimes attains to 30 feet. The stone in the upper portion is bluish gray in color, and closely resembles the upper layers in the J. B. Blanton quarry. The stone in the lower portions of the quarry is grayish white to white in color, and closely resembles the lighter stone in the J. B. Blanton quarry.

The road crusher at this plant has a capacity of 150 tons per day. Four different sizes of crushed stone are manufactured. No. 1, 2 inches in diameter, No. 2, 1½ inches in diameter, No. 3, 1 inch in diameter, No. 4, screenings, ½ inch in diameter. The product of this quarry was used in building the concrete blocks for the warehouses at Lock No. 4 on the Kentucky River. Two wheelbarrows of screenings to 1 bag of cement meets the State requirements for road construction. This equals 4 to 1 by weight.

4. Kate Williams Quarry. This quarry is situated on the Devil's Hollow pike, about 1¼ miles west from Frankfort. The stone is of bluish gray color, and a good road building stone. It corresponds to the upper layers at the quarry of the Frankfort Stone Company. This stone was used in building Lock No. 6 on the Kentucky River.

5. Lillis and Harrod Quarry. This quarry is situated 1 mile northwest of Frankfort, on the Bald Knob pike. The stone is of bluish gray color, and a good road building stone.

6. This quarry is situated directly south of the city, just beyond the entrance to the Louisville pike.

7. An old quarry was reported at Lock No. 4 on the Kentucky River, about 1 mile north of Frankfort. The stone was used in building the lock and dam at this place.

8. This quarry was located on the old John R. Scott farm the same distance from Frankfort.

9. This quarry is in the neighborhood of South Elkhorn, about the same distance from Frankfort.

10. W. H. Perkins Quarry. This quarry is on the Frankfort-Lawrenceburg pike, 4 miles from Frankfort. The quarry is approximately 100 feet in length with the height of the working face, 20 feet. The stone is gray in color, thin bedded, mostly hard, but with some shaly layers. The quarry is now idle, but the stone removed was used for macadam. If the soft beds are used, the stone must be unsatisfactory for road work.

11. Dr. John P. Stewart Quarry. This quarry is located on the Stewart farm near Farmdale. Besides other ordinary structural limestone it produces a semi-crystalline crinoidal limestone which takes a beautiful polish, and is therefore a commercial marble.

Gallatin County.

The terranes of Gallatin County comprise both shales and limestones. The shales are too weak for road work, and the limestones are too thin bedded and soft for satisfactory road construction. The only quarry known in the county is in these thin bedded limestones a few miles south of Warsaw.

Garrard County.

The essential road building stones of Garrard County are limestones and marbles. The compact, fine grained, dove colored limestone attains a thickness of 50 feet. The gray and mottled marbles reach a thickness of 30 feet. The buff limestone is about 10 feet in thickness. These rocks were quarried as early as 1850 for road construction.

1. Bryantsville Quarry. This quarry is situated near Bryantsville, and about 10 miles northwest from Lancaster. The bluffs here rise so high, and are so long that the supply of stone seems to be inexhaustible. The stone ranges in color from white

to light gray, and is of uniform texture. It has been used for macadam.

2. This quarry is near Lancaster, and has furnished stone for road construction.

Grant County.

The limestones of Grant County are thin bedded, of medium to dark gray color. The Queen & Crescent Route of the Southern Railway System passes north and south through the center of the county, and has used the local thin bedded limestone for railroad ballast. The thin beds are used also for abutments, bridges, curbing and road work, but this use is purely local.

Harrison County.

The road building stones of Harrison County are limestones and marbles. The limestones are of light gray and medium gray color. The marbles are of medium gray and dark gray color. They are all fine grained and even textured.

The marbles are well crystallized and susceptible of a high polish. They cut to a sharp edge, hammer white, and the contrast is strong between hammered and polished surfaces.

1. J. R. Poindexter Quarry. This quarry is situated about three-fourths of a mile southeast of Cynthiana. The length of the quarry is 300 feet, the breadth is 50 feet, and the altitude of the working face about 20 feet. The stone is also easily worked into paving blocks, and is now largely used in the construction of the new Lair pike.

2. The McGibben Quarry. This quarry is about three-fourths of a mile south of Cynthiana. The stone has been used in a large number of retaining walls and dams.

3. Jack Lemons Quarry. This quarry is about 1 mile southeast of Cynthiana. It produces a light gray road building stone.

4. Pleasant Street Quarry.This quarry has now been abandoned, although it still contains good stone.

5. William Redmond Quarry. This quarry is situated 1 mile east of Cynthiana, on the old Lair pike. It is now owned by Jack Lemons. This quarry is now idle.

6. Belmont Quarry. This quarry is 1 mile west of Cynthiana. It has been abandoned on account of a heavy overburden that demanded too great an expense in stripping.

7. Quincy Ward Quarry. This quarry is situated about 2 miles southeast of Cynthiana on the new Lair pike. The stone is grayish white and crystalline. It is one of the best road building rocks in the county. It has a crusher and the product is used in the construction of the new Lair pike.

8. The County Quarry. This quarry is on the Oddville pike, one-half mile east of Cynthiana. It carries a crusher and the stone is used on the county roads.

9. Oddville Quarry. This quarry is on the Oddville pike, 4 miles east of Cynthiana. The stone is being used on the Oddville pike.

10. Helms Quarry. This quarry is on the Falmouth pike, 2 miles north of Cynthiana. It is inactive.

Henry County.

As a rule, the formations are thin bedded and would produce road building stone only in limited quantities for local use. Along the Kentucky River, which forms the northeastern boundary of the county, the bluffs rise over 350 feet above low water and in their lower portions good road building stones can be secured.

1. Lockport Quarry. This quarry is located at Lockport, on the Kentucky River. The quarry was opened to furnish stone for the lock and dam at Lockport.

2. Gestville Quarry. This quarry is situated at Gest, formerly Gestville, on the Kentucky River. The stone was quarried for the construction of the lock and dam at Gest. It possesses the same characteristics as the stone at Lockport.

3. Jericho Quarry. This quarry is near the small station at Jericho, on the Louisville & Nashville Railroad. The stone has been used as ballast and macadam.

4. Pendleton Quarry. This quarry is situated at Pendleton, a small station on the Cincinnati Division of the Louisville & Nashville Railroad. The stone is used for ballast and macadam.

5. This quarry is near New Castle. The stone was quarried for macadam.

6. Jim Wilson Quarry. This quarry is 1½ miles northwest of New Castle and 2 miles north of Eminence. There is an overburden of 15 feet of shale and only 8 to 10 feet of road stone. The length of the quarry face is 175 feet. The limestone is semi-crystalline. The stone is being used on the Shelby-Eminence road, 46, Section C.

7. County Quarry. This quarry is ½ mile north of the Jim Wilson quarry and on the right hand side of the Eminence-New Castle pike. There is an overburden of 10 to 15 feet of shale and only 7 to 10 feet of good limestone.

8. G. T. Allison Quarry. This quarry is in the south part of New Castle. A 15 to 20 foot working face could be secured for some 200 feet in length. It appears a better stone than No. 7.

9 Dr. Elliston Quarry. This quarry is ½ mile north of New Castle. The stone has been used in road construction at 46B.

10. Dr. Webb Sutter Quarry. This quarry is ½ mile from 46B on the New Castle-Carrollton pike. The quarry contains several beds of limestone 2 feet in thickness with no shale layers between them. The stone is of bluish gray color and semi-crystalline. The percentage of wear of the sample collected this summer is 7.5.

Jefferson County.

The road building rocks of Jefferson County are all limestones The quarries in the eastern environs of Louisville are so numerous, and change ownership so often, that it becomes impractical to list them all. In all probability more quarries have been opened in this county than in any other county of the State. There is said to be a greater mileage of permanent and improved roads in Jefferson County than in any other county. The supply of road building material is inexhaustible.

The limestones in general are well suited for abutments, bridges, retaining walls, railroad ballast, paving blocks, and macadam. Some of them carry 10 per cent of silica and a sufficient amount of clayey matter, so that when burned and ground,

the finished product has the property of setting. The product is hydraulic cement.

In color these limestones range from a very light gray, through a medium gray to a dark bluish gray. Some of them are

22. WORK HOUSE QUARRY, LOUISVILLE.
This quarry is in Louisville, Jefferson County, Ky. It shows thickness of the limestone beds.

very fine grained, even textured, and break with an angular fracture. Others are medium to coarse grained. Some are microcrystalline, while others are well recrystallized. The maximum thickness of an individual layer reaches 10 feet.

All the limestones of Jefferson County, whether dolomitic or otherwise, are extensively used for macadam. The largest shipping quarry outside the city of Louisville is at Tucker, a station on the Southern Railroad, Louisville and Lexington Branch.

1. City Work House Quarry. This quarry is situated 3 miles east of the courthouse. Some of the individual beds are quite blue on their fresh surfaces, others are of light bluish gray color. The thickest individual bed was 7 feet. Several beds were 5 feet in thickness. The total length and breadth of the quarry were approximately equal, 750 feet. The height of the present working face was 20 feet. There is much excellent road building stone at this quarry.

The crusher at this quarry has a capacity of 100 tons per

day. Four different sizes of stone are manufactured. No. 1, 2 inches in diameter, used in road bed; No. 2, 1 inch in diameter, used as a binder; No. 3, ½ inch in diameter, used for covering and patch work; No. 4, dust, used for top dressing.

2. This quarry is some 30 rods beyond the work house. It contains the same type of limestone as the work house quarry. The quarry was abandoned for want of ownership of more quarry land, but the supply of stone is not exhausted.

3. Henry Bickle Quarry. This quarry is situated 4 miles east of the courthouse on Raymond Avenue, between Frankfort Avenue and the Work House road. There are 15 acres in the quarry. The stone is excellent for road work.

4. Steugle Quarry. This quarry is in the same neighborhood, and is the same type of stone as No. 3.

5. Shank Quarry. This quarry is in the eastern part of Louisville. It produces most excellent road building stone.

6. Wm F. Woodruff Quarry. This quarry is some 4 miles northeast of the courthouse, near the Blanken Baker Station on the Pewee Valley electric line. It is the largest quarry around Louisville. It is regarded as one of the best road building rocks in the State.

7. Jim Taylor Quarry. This quarry is 2 miles northeast of the courthouse on the interurban trolley line near Water Works Station.

8. Atkins and Staebler Quarry. This quarry is at Doats Point, 2 miles southeast from the courthouse, and about ½ mile from the city line.

9. Camp Taylor Quarry. This quarry is situated on the Paducah or Poplar Level road, 4 miles south of the courthouse. It is a little north of Camp Taylor. The stone was used in the construction of the camp.

10. Charles Bameister Quarry. This quarry was also called the Pewee Valley Quarry. It is owned and operated by Chas. Bameister. It is about 20 miles east to northeast of Louisville. It has a crusher with a 100-ton capacity.

11. L. & N. Quarry. This quarry is at Avoca, on the Louisville & Nashvile Railroad, 17.3 miles east of Louisville. The stone is used for railroad ballast.

12. Edgar Cox Quarry. This quarry is some 20 miles east of Louisville between Avoca and Anchorage.

13. Jefferson County Quarry. This quarry is on the Brownsboro pike, 8 miles east by southeast of the courthouse. The stone is used for macadam.

14. R. B. Taylor Quarry. This quarry is some 20 miles south of Louisville, and the stone is used for macadam.

15. The Tucker Quarry. This quarry is in the Laurel dolomite. The stone is used for road metal. The quarry is the largest in Jefferson County outside of the city of Louisville.

16. Beargrass Quarry. This quarry is in the eastern part of Louisville.

17. There is an abandoned quarry near the city water works. It still carries much good road building stone. It is about 3½ miles northeast of the courthouse.

18. Cemetery Quarry. This quarry is a little to the northeast of Cave Hill Cemetery in a meander of Middle Fork.

19. Kosmos Portland Cement Co. Quarry. This quarry is located on the Ohio River at Dugan's Landing, Ky. The relative dimensions of the quarry are: length, 1,680 feet; breadth, 900 feet, height of working face at highest point, 110 feet. The upper 36 feet is in high grade limestone, then 22 feet dolomitic limestone, then 40 feet of high grade limestone, then 5 feet of very pure limestone followed by 7 feet of impure limestone.

Jessamine County.

The terranes of Jessamine County are all limestones. It is interesting to note that the three oldest and, therefore, lowest geologic formations in the State are well represented in this county. They are the Camp Nelson formation, 285 feet in thickness. The Oregon formation, 15 to 25 feet in thickness. The Tyrone formation, 90 feet in thickness, thereby making the maximum thickness of the High Bridge Series 400 feet. The characteristics of these limestones were given in this chapter under Anderson County. The supply of stone is inexhaustible.

1. High Bridge Quarry. This quarry is on the east side of the Kentucky River at High Bridge. The quarry is owned by the American Stone and Ballast Company of Cincinnati,

Ohio. The operators and managers are Dorman and Utter. The quarry has been in continuous operation for over 20 years. The quarry face does not mark a straight line. Its circuitous length is 1,200 feet. Its breadth is 750 feet. Its height as measured by an aneroid barometer is 62 feet. It is one of the largest quarries in the State. The individual beds are from 2 to 4 feet in thickness, and contain much valuable road building stone.

There is at this quarry a very large rock crusher which makes a larger variety of crushed stone than most crushers throughout the State. No. 1 is 4 inches in diameter, No. 2 is 3 inches in diameter, No. 3 is 2 inches in diameter, No. 4 is 1 inch in diameter, and No. 5 is screenings and dust.

2. This is a small quarry on the right of High Bridge.

3. This is a small quarry on the left of High Bridge. The stone removed from both has only been used locally.

4. Glass Mill Quarry. This quarry is situated between Wilmore and Glassmore. The beds are from 2 to 4 feet in thickness, and the product is a good road building stone.

5. Davis and Delong Quarry. This quarry is on a branch road from the main road from Wilmore to High Bridge. The quarry is several hundred feet in length, and quarried at three different openings. The quarry face is from 10 to 15 feet in height The beds are thick, and the stone is good.

6. Camp Nelson Quarry. This quarry is at Camp Nelson on the north bank of the Kentucky River.

7. Rev. D. W. Alexander Quarry. This quarry is situated 6 miles east of Nicholasville. The stone is good.

8. Marble Creek Quarry. This quarry is in the fine grained dove colored, even textured Tyrone formation, which furnishes a large amount of road metal.

Kenton County.

The limestones of Kenton County are thin bedded. They are of gray to bluish gray color. The numerous shaly layers or partings render the stone weak for road construction.

1. City Quarry. This quarry is situated on the Altamont road, 2 miles southwest of Covington. The quarry is 800 feet in length, 100 feet in breadth, and the height of the working face

is 35 feet. The thickest bed of limestone in this quarry is 12 inches. The stone is used for foundation work, abutments, bridges, culverts, curbing and road construction.

2. Scholler Quarry. This quarry is on Highland pike, 3 miles southwest of Covington. The length of the quarry is approximately 900 feet, the breadth is 150 feet, and the height 40 feet. The stone is used for the same purposes as No. 1.

3. This quarry is located about 3 miles south of Covington on the Lexington pike. It is now inactive, but it is operated intermittently for purposes of road construction.

Lincoln County.

The road building rocks of Lincoln County are all limestones. Some of these are fine grained and even textured. Others are well crystallized and are susceptible of a high polish.

1. Stanford Quarry. This quarry is situated near Stanford. The stone is used for road construction.

2. Knob Lick Quarry. This quarry is located near Knob Lick. The stone is used for road work.

3. Quarry Prospect. This prospect is located 2 miles east of Crab Orchard. The well crystallized marble ledge is 14 feet in thickness at the exposure. It should make a very good road metal.

4. Gilberts Creek Quarry. Near Gilberts Creek there is a fine grained, even textured, pink marble traversed by dark zigzag bands closely resembling the pink Tennessee marble.

Madison County.

The terranes of Madison County are widely varied in composition and age. The rocks in the southern and western part of the county are thin bedded and shaly and from them little or no good road building material can be expected. The High Bridge Series along the Kentucky River can furnish much excellent road building stone.

1. Ford Quarry. This quarry is near Ford, a small station on the Louisville & Nashville Railroad, about 10 miles north of Richmond. It has furnished good road stone.

2. City Quarry. This is a small quarry near Richmond

that has furnished stone for curbing, etc., in Richmond. The stone is good.

3. Berea Quarry. This quarry is situated to the south of Berea, and a little to the east of the Louisville & Nashville Railroad. It furnishes sandstone for abutments, bridges, culverts, curbing, etc.

4. County Quarry. This quarry is used entirely in the construction of permanent roads.

Marion County.

The Silurian, Devonian and Mississippian rocks are all too thin bedded and too shaly to produce good road building stones. The Maysville formation of the Cincinnatian series furnishes some road building stones. These vary in color from a light or cream gray to a bluish gray. In texture, they vary from fine grained to coarse grained. Some of the calcite crystals exceed ½ inch in diameter, and both the larger and the small crystals show perfect rhombohedral cleavage. The stone is so completely recrystallized that it takes a good polish. A polished sample can be seen as No. 69a in the museum of the Kentucky Geological Survey. It is classified as one of the Kentucky marbles. The stone weathers white. Dark zigzag bands occasionally traverse the stone. The percentage of wear is apt to be high in all the recrystallized limestones of Marion County.

1. Chicago Quarry. This quarry is situated near Chicago, a small station on the Louisville & Nashville Railroad, about 10 miles west by northwest of Lebanon. The quarry is in thin bedded limestone, and the product is used entirely in road construction.

2. T. M. Estes Quarry. This quarry is located within the city limits of Lebanon, a little north of the courthouse. The stone has been used quite extensively for road building purposes. It is very good.

3. T. M. Estes Quarry. This quarry is located on the Springfield pike, 1 mile north of the courthouse. It contains both the light gray and the bluish gray, well crystallized varieties of limestone. The individual beds are from 2 to 4 feet in thickness. The rock is an excellent building stone. The large

blocks should be sawed, and care taken to reject all blocks that show evidence of dead seams, for in some of these dead planes a little iron sulphide occurs.

4. Stephen Rogers Quarry. This quarry is on the Bradfordsville pike, 4 miles southeast of Lebanon. The stone is used in road construction.

5, 6, 7, 8, 9. These quarries are all on the Danville pike, within 6 miles of Lebanon. The first is almost 2 miles west of Lebanon, and the others about 1 mile apart. The stone is used for foundations and macadam.

10. St. Mary Quarry. This quarry is situated at St. Mary, a small station on the Louisville & Nashville Railroad, about 3 miles west of Lebanon. The stone is a fair road building stone that weathers white.

11. Humphrey Quarry. This quarry is on the Springfield pike, 4 miles north of Lebanon. It is a good road stone.

12. Jackson Lane Quarry. This quarry is situated 2 miles south of the courthouse. The stone is thin bedded, and is used in road construction.

13. Miller Pike Quarry. This quarry is on Miller pike, 3 miles southwest of Lebanon. The stone is used for macadam.

14. Jimtown Quarry. This quarry is within the city limits and near the Campbellsville pike. The stone is used for macadam.

15. Rains Hill Quarry. This quarry is also within the city limits. The stone is used for macadam.

16. Loretto Quarry. This quarry is at Loretto. The stone is of light gray color, weathers white, and is pleasing in its effect. It is a very good road building stone.

Mason County.

Practically all the limestones of Mason County are thin bedded and intercalated more or less with shaly layers. In color they are blue, bluish gray, gray, and dark gray. They are fine to medium grained in texture. They are massive, hard and some of them resistant to the corrosive agents of the atmosphere. Some of them are sufficiently recrystallized to be classified as marbles. They are susceptible of a high polish, and the contrast is marked

33. County Quarry. This quarry is on the Minerva and Tuckahoe pike, 6 miles west of Maysville.

34. County Quarry. This quarry is on the Hill City pike, 6 miles south of Maysville.

35. County Quarry. This quarry is 5 miles south of Maysville, on the Hill City pike.

Mercer County.

The road building rocks of Mercer County are all limestones. The three lowest formations of the State, the Camp Nelson, Oregon and Tyrone, form the high bluffs along the Kentucky River on the eastern boundary of the county. In scaling the bluffs from the Kentucky River to Shakertown, over 300 feet of rock is traversed. The supply of road building material from these three formations is inexhaustible. The overlying gray, granular, crystalline limestone has furnished several quarries for road building material, but the best results will be obtained when the stone is not too coarse grained and not too highly crystallized.

1. Shakertown Quarry. This abandoned quarry was in the Tyrone formation under the bluffs of the Kentucky River. There has been so much work done in constructing the road from Shaker Ferry to Shakertown that the exact location of the quarry was not made. The limestones of this bluff in Mercer County can furnish an inexhaustible supply of good road building stone.

2. Harrodsburg Quarry. This quarry is situated within the city limits of Harrodsburg. It has furnished a considerable amount of road building stone for use around Harrodsburg. The stone is of bluish gray color and weathers nearly white. It belongs to the Lexington formation.

3. This quarry is just outside the little hamlet of Shakertown, on the Shakertown-Danville pike. It is used for macadam.

4. This quarry is also on the Shakertown-Danville pike about 2 miles from Shakertown. It is used in road work.

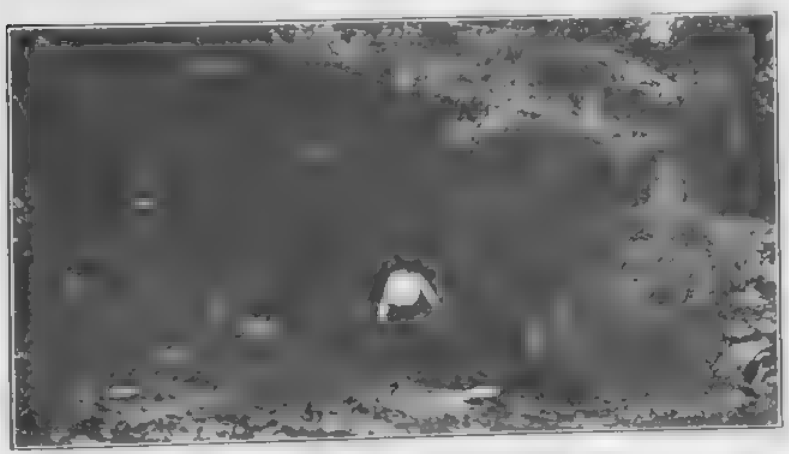
5. Burgin Quarry. This quarry is near the little village of Burgin, 2 miles southeast of Harrodsburg. The stone is used for macadam.

6. This quarry is about 1 mile northwest of Harrodsburg

on the Cornishville pike. The stone is well suited for road building purposes.

Montgomery County.

The limestones of Montgomery County are as a rule thin bedded, and more or less intercalated with shale. The shale disintegrates rapidly, and leaves in numerous cuts and exposures the more resistant limestones protruding from the retreating shale. The limestones are gray, bluish gray, and dark gray in color. They are fine grained and even textured. Some of them are well recrystallized and susceptible of good polish. They hammer white, and the contrast is strong between the white hammered faces and the dark gray polished surface. These limestones have been used for foundations, trimmings, abutments, bridges, culverts, curbing, paving, railroad ballast and macadam.



2. MOBERLY QUARRY ON PARIS PIKE

This quarry is situated 4 miles from Mt. Sterling, Montgomery County, Ky. The stone tests the State's supreme [illegible]

1. De Bard Quarry. This quarry is situated on the Winchester pike, one-half mile west of Mt. Sterling.

2. Kelly Quarry. This quarry is on the Winchester pike, 2 miles west of Mt. Sterling.

3. Stengall Quarry. This quarry is on the Levee pike, 1 mile from Mt. Sterling.

4. Winn Quarry. This quarry is on the Hinkston pike, 1 mile from Mt. Sterling. Both the gray and blue varieties are present. The dark gray bed receives a good polish, and is a good

24. LIMESTONE QUARRY OF J. W. RICHARDS.
This quarry is on the Hinkston Pike, ¼ mile from Mt. Sterling, Montgomery County, Ky. All stone below the head of the hammer is good. The upper portion is poor, because soft and shaly.

road building stone. The best beds are at the bottom of the quarry. This quarry is now owned and operated by J. W. Richards. The quarry is 300 feet in length, 200 feet in depth, and with a working face 30 feet in height. It could be easily worked 10 feet deeper. The crusher at this quarry has a 100-ton capacity.

5. Grassy Lick Quarry. This quarry is on the Grassy Lick pike, 2½ miles west of Mt. Sterling. It was inactive.

6. Thompson Quarry. This quarry is on the Maysville pike, 3 miles north of Mt. Sterling. Both the gray and blue limestones occur at this quarry.

7. Clarence White Quarry. This quarry is on the Maysville pike, 4 miles north of Mt. Sterling.

8. Peter Kelley Quarry. This quarry is on the Maysville pike, 1½ miles north of Mt. Sterling. Both the blue and gray varieties are present. It is a very good quarry.

9. Camargo Quarry. This quarry is on the Camargo pike, 1½ miles from Mr. Sterling.

10. Mitchell Quarry. This quarry is on the Winchester pike, one-fourth mile west of Mt. Sterling.

11. Moberly Quarry. This quarry is on the Paris pike, 3½ miles northwest of Mt. Sterling. It was sampled by the author this summer, and found to meet the State specifications. The stone was used in the construction of Federal Road No. 32. See. B-1.

12. Johnson Quarry. This quarry is on the Paris pike, 3 miles northwest of Mt. Sterling.

13. Wren Quarry. This quarry is on the Van Thompson pike, 7 miles northeast of Mt. Sterling.

14. City Quarry. This quarry is on the Spencer pike, 6 miles east of Mt. Sterling. The quarry is in a buff and yellowish sandstone. The individual beds range from 18 inches to 3 feet in thickness. The stone is used for abutments, bridges, foundations, etc.

15. Bryson Quarry. This quarry is on the Maysville pike, 7 miles north of Mt. Sterling.

16. James White Quarry. This quarry is on the Maysville pike, 4½ miles north of Mt. Sterling.

17. Gatewood Quarry. This quarry is on the Step Stone pike, 3 miles east of Mt. Sterling.

18. Turley Quarry. This quarry is on the Levee pike, 1½ miles south of Mt. Sterling.

19. Anderson Quarry. This quarry is on the Levee pike, 3½ miles south of Mt. Sterling.

20. Tremble Quarry. This quarry is on the Camargo pike, 5 miles south of Mt. Sterling and ½ mile southeast of Camargo. It is in sandstone.

21. Hastie Quarry. This quarry is on the Judy and Flat Rock pike, 7 miles northwest of Mt. Sterling. The stone is very good for road building purposes.

22. W. F. Henry Quarry. This quarry is on the Judy and Flat Rock pike, 7½ miles northwest of Mt. Sterling. It contains good road building stone.

23. W. F. Henry Quarry. This quarry is on the Side View and Aaron River pike, 8 miles northwest of Mt. Sterling. The quarry has a working face 20 feet in height.

24. Flanders Quarry. This quarry is on the Judy and Flat Rock pike, 8½ miles northwest of Mt. Sterling.

25. Davis Reed Quarry. This quarry is on the Winchester pike, 3 miles west of Mt. Sterling.

Pilot Knob. There is an outcrop of Pottsville Conglomerate on Pilot Knob that is worthy of more than passing mention. Pilot Knob is located about 9 miles south of Mt. Sterling, Montgomery County. A part of the Knob is in Montgomery and a part is in Powell County.

It is furthermore said to be within 2½ miles of the Louisville & Nashville Railroad, from which a spur may be easily extended to the base of the Knob. The conglomerate itself occupies a somewhat semi-circular ridge, with an axis in a northeasterly direction. This outcrop is more than one-half mile in length, and would doubtless average 200 feet in width. This average cannot be ascertained at the surface, for the crest of the ridge is very narrow. The study of the gravel from which the cement holding the pebbles together has been dissolved out leads to the conclusion that the loose, incoherent gravel is comparatively

shallow, and that the true conglomerate or cemented gravel lies buried beneath it. The depth of the gravel, or conglomerate, is in places definitely proven to be 75 feet in thickness, and may be 100 feet in thickness. On the right hand side of the central knob is one of the best places to ascertain the thickness, but even here there is no proof positive that decomposition has been extended to the bottom of the conglomerate. It would require development work to ascertain its actual thickness. At present no development work has been executed upon this property.

An excellent place to open up a quarry is between the shelf of rock at the south end of the central knob and the north end of the knob at whose base there is a fine spring. The amount of gravel that can be removed at this point without blasting is unknown, because no excavations have been made in the material. Furthermore, this point is desirable for opening a quarry because the overburden of compact sandstone is here reduced to a minimum. Therefore, there is practically no waste to be discharged into the large valley to the north.

This overburden when actually encountered may be itself with the few pebbles that are scattered through it an excellent railroad ballast, or road building rock, and the author would suggest that when perfectly fresh and undecomposed rocks are quarried, that a forty-pound sample, preferably in four pieces, be sent to Prof. D. V. Terrell, University of Kentucky, Lexington, Kentucky, for analysis as to its value in road construction. This value cannot be determined without a fresh rock upon which to make the test.

The conglomerate itself with pebbles varying in size from a small pea to that of a hen's egg is in the author's judgment an ideal railroad ballast. While that may hold true of the gravel that has already been worked into incoherent pebbles by the prolonged action of the atmosphere, it does not prove that the fresh and unweathered portions that will be encountered in the quarry work will be of equal value. Neither can the character of the conglomerate, that is, the ease with which the conglomerate will break down into pebbles, be determined until a quarry has been opened as suggested, and the material broken up ready for

shipment by railroad. In blasting the material, difficulties will be encountered in drilling superior to those met with in drilling limestone, for the hardness of each quartz pebble, and this is practically the only pebble in the gravel, is seven in the scale of hardness, while the hardness of calcite crystals in the crystalline limestone is only three.

The cement binding these pebbles together is largely the oxides and hydrous oxides of iron. There is some clayey matter in the cement at the surface exposures, but the amount is small. The conglomerate varies somewhat in the coarseness of the pebbles. There will be encountered from time to time in the process of work sands that are fine enough and pure enough for the manufacture of high grade cements; the value of such sand is superior to the value of the conglomerate used direct for railroad ballast. The supply of this conglomerate is practically inexhaustible.

Nelson County.

The road building stones of Nelson County are mostly limestones and marbles. They are white or grayish white, gray, bluish gray, and mottled. Some of them are traversed by dark zigzag bands. Some are well crystallized and susceptible of a polish. One suggests when polished a Circassian Walnut color that is very pleasing in its effect. The individual layers are usually thicker bedded than they are in the eastern counties in the Bluegrass region.

1. City Quarry. This quarry is within the city limits of Bardstown, on the east side of the courthouse. The length of the quarry is 300 feet, the breadth is 100 feet, and the height of the working face is 12 feet. The top rock, 2 to 3 feet, is a variegated sandstone. The remaining 9 to 10 feet is in gray limestone, and the solid quarry floor is in hard, dark blue limestone.

2. Jenkins Quarry. This quarry is on the Bardstown pike, 3½ miles north of the courthouse. It is 200 feet in length, 50 feet in breadth, and the height of the working face is 13 feet. It is in a very hard, bluish gray limestone. There is a crusher

at this plant with 100-ton capacity. The product is a most excellent road stone.

3. This quarry is also on the Bardstown pike, a little further north than No. 2. The hard blue limestone beds here are from 18 inches to 2 feet in thickness, while the gray limestone beds range from 3 to 8 feet in thickness. It contains good road building stone, but has been inactive since 1911.

4. County Quarry. This quarry is on the Elizabethtown pike, 1 mile west of the courthouse. The quarry is 200 feet in length, 75 feet in breadth, and the height of the working face is 12 feet. There is one bed 6 feet in thickness. There is a banded layer 2 feet in thickness, and a blue layer at the bottom 5 feet in thickness.

5. This is a private quarry on the Elizabethtown pike, 7 miles west of Bardstown. There is about 5 feet of buff sandstone at the top of the quarry, and 10 feet of white limestone beneath the sandstone.

6. County Quarry. This quarry is on the Elizabethtown pike, 5 miles west of the courthouse. The quarry is 75 feet in length, 50 feet in breadth, and the height of the working face is only 8 feet. All the beds are white or faintly grayish white in color, massive, fine grained, and even textured. It is regarded by the author as the best road stone, and the best agricultural stone in the county. This rock was reported to contain over 99 per cent of calcium carbonate.

7. Dr. Wright Quarry. This quarry is situated on the Bardstown and Fairfield pike, 8½ miles northeast of the courthouse. The individual beds range from 5 to 7 feet in thickness. It is in the hard blue limestone, which is an excellent road stone.

8. County Quarry. This quarry is near Woodlawn, 6 miles east of Bardstown. The quarry is 60 feet in length, 30 feet in breadth, and 8 feet in height of working face. The individual beds are from 1 to 2 feet in thickness, gray in color, and compact. It is a good road building stone.

9. County Quarry. This quarry is on the Springfield pike, 5 miles southeast of the courthouse. The quarry is 100 feet in length, 50 feet in breadth, and with a height of working face 8 feet. It is in very massive blue limestone.

10. County Quarry. This quarry is 11 miles south of Bardstown, near the small station of New Haven on the Louisville & Nashville Railroad. This quarry is 40 feet in length, 20 feet in breadth, and 5 feet in height of working face. The quarry is in the gray limestone. The floor of the quarry is solid limestone, and the quarry can be advantageously worked to a greater depth.

11. New Hope Quarry. This quarry is one-half mile north of New Hope. It is owned and operated by Thomas Miller. The quarry is 50 feet in length, 30 feet in breadth, and the height of working face is 14 feet. It is in the gray limestone, with individual beds ranging from 2 to 3 feet in thickness. It is a good road building stone.

12. County Quarry. This quarry is located 1 mile north of Deatsville. The quarry is 100 feet in length, 75 feet in breadth, and the height of the working face is 8 feet. It is in the gray limestone and is well suited for road construction.

13. D. Meirfield Quarry. This quarry is 2 miles west of Bloomfield. The top of the quarry is in the blue limestone and the bottom is in shale.

14. Ed. Lewis Quarry. This quarry is 2 miles north of Bloomfield. The quarry is in the blue limestone.

15. Henry Muire Quarry. This quarry was within the city limits of Bardstown. In the early history of Bardstown this quarry furnished much stone for foundations, abutments, bridges, curbing, etc.

16. This quarry is situated about 9 miles from Bardstown on the Bloomfield pike. The stone is too soft and friable for road work. The quarry should be abandoned.

17. This is a small quarry one-half mile north of Deatsville. It is in the gray limestone.

Nicholas County.

The limestones of Nicholas County are usually thin bedded and of gray to bluish gray color.

Paul D. Darnell, Road Engineer of Nicholas County, has kindly furnished the author with the following list of quarries for this county:

Name	Distance from Carlisle, Ky.	Owner	Pike Location	Foundation	Road Work
(1) Johnson	6 miles	County	Maysville & Lexington	Yes	Yes
(2) Sims	1 mile	J. Sims	Upper Jackstown	Yes	Yes
(3) Piper	3 miles	W. L. Piper	Lower Jackstown	Yes	Yes
(4) Brady	1 mile	D. Westfall	Miller	Yes	No
(5) Barton	4 miles	County	Myers Station	Yes	Yes
(6) Linville	1½ miles	County	Scrub Grass	Yes	Yes
(7) Parker	1 mile	C. Hamilton	Morefield	Yes	Yes
(8) Reinsmith	4 miles	County	East Union	Yes	Yes
(9) Weaver	8 miles	S. Weaver	Roost	Fair	No
(10) Bramblett	7 miles	H. Bramblett	Clark Road	Yes	Fair

No stone used for building purposes other than foundations.

Oldham County.

The gray and blue limestones of Oldham County are in general thin bedded and intercalated with shaly layers. There are some beds, however, that are sufficiently massive for road building stone. This holds especially true along the Ohio River, where the limestone is sufficiently recrystallized to receive a good polish.

1. La Grange Quarry. This is the quarry that has furnished stone for foundations, abutments, bridges, curbing, etc., around La Grange, the county seat of Oldham County.

2. Floyd's Fork Quarry. The hard resistant limestone around Floyd's Fork has been quarried for local use.

Owen County.

Good road building stones may be obtained in Owen County along the Kentucky River, where the High Bridge and Lexington outcrops form the high bluffs. The Cynthiana formations in both the eastern and western portion of the county are not as satisfactory a road metal. They are comparatively soft and the percentage of wear is too high.

1. Owenton Quarry. This quarry is near Owenton. It is in the blue limestone, and has furnished stone for abutments, bridges, culverts, curbing, etc., for local use.

2. Lockport Quarry. This quarry is at Lockport on the Kentucky River, some 10 miles southwest of Owenton. It furnished the stone for the lock and dam at Lockport.

3. Monterey Quarry. This quarry is on the Kentucky River, almost directly across the river from Gest. It is reported to have furnished stone for the same lock and dam as No. 2.

4. Gratz Quarry. This quarry prospect is on the Gratz-Owenton road, 191). A quarry face can be secured in this limestone hundreds of feet in length, both in and just outside the village of Gratz. The supply is ample. The surface sample gave a percentage of wear of 7.7. The water absorbed in 24 hours was 1 part in 15.5.

5. This quarry prospect is on the Owenton-Frankfort pike, 1½ miles south of Monterey, station unknown. The limestone is grayish white in color and fairly well recrystallized. The supply is ample. The percentage of wear of this stone is 7.2.

Pendleton County.

In general the limestones of Pendleton County are thin bedded and intercalated with shaly layers. The thicker bedded, harder, more resistant gray, bluish gray, and dark gray beds afford some good road building stone.

1. City Quarry. This quarry is near Falmouth. It has furnished some road building stone for local use.

2. Ivor Quarry. This quarry is situated at Ivor, a small station on the Chesapeake & Ohio Railroad in the extreme northeastern corner of the county. It has furnished some good road building stone for local use.

3. County Quarry. This is situated about 2½ miles south of Falmouth. It has a rock crusher and the stone is used for road work.

4. This quarry is about 5 miles south of Falmouth. The stone is used in road work.

5. This quarry is about 5 miles southwest of Falmouth.

The stone can be used for road building purposes. It is the best road metal in the county.

6. This quarry is about 2 miles east of Falmouth. The stone is used for macadam.

7. This quarry is about 3 miles northeast of Falmouth. The stone is used for macadam.

8. Trapp Brothers Quarry. According to B. B. Barton, County Road Engineer, there is a good quarry at Menzie Station on the Louisville & Nashville Railroad, 8 miles north of Falmouth. There are 48 acres in the quarry land. The stone is suited for foundations, curbing, and road construction.

Robertson County.

The limestones of Robertson County are generally thin bedded and intercalated somewhat with shaly members. These limestones are gray, bluish gray, and dark gray in color. The Eden shales are too shaly and friable to furnish road building stone. As no railroad traverses any part of this county, only stone for local use can be expected.

1. County Quarry. This quarry is situated a little south of Mt. Olivet. It has furnished stone for macadam.

Scott County.

Scott County is fortunate in possessing good road building stone worthy of more than local use. The limestones and marbles are white or nearly white, grayish white, gray, bluish gray, and dark gray in color. The tendency of all these rocks is to weather white. In texture they range from fine grained to coarse grained. They are massive and thick bedded in most of the quarries. They are microcrystalline to completely recrystallized limestones which may be classified as marbles. Many of them are susceptible of a high and beautiful polish. They are well suited for foundations, abutments, bridges, culverts, curbing, retaining walls, railroad ballast, and macadam.

1. Slaughter House Quarry. This quarry is about 1 mile southeast of Georgetown. The stone is in part gray and in part grayish white in color, semi-crystalline to crystalline, and re-

ceives a good polish. This holds especially true of the lower 10 feet of stone in the quarry. The quarry is now owned by Mr. Hambrick. The length of the quarry is 200 feet, the breadth 50 feet, and the height of the working face is 20 feet. There is a crusher at this quarry.

2. Spedden Smith Quarry. This quarry is within 50 rods of the Slaughter House quarry. It is a little smaller in dimensions and the stone is a little darker in color than No. 1. It is well crystallized, and susceptible of a high polish.

3. Albert Vaughn Quarry. This quarry is situated about 50 rods south of the Slaughter House quarry and is about equal to it in size. An analysis of this stone was reported to give 99.5 per cent of carbonate of lime. If the report is correct, this is one of the purest limestones known. An old lime kiln was found here, and the stone formerly was burned for lime for both building and agricultural purposes.

4. City Quarry. This quarry is on the north side of the city, three-fourths of a mile from the courthouse. It has a crusher with a capacity of 100 tons per day. It is a good quarry.

5. Fannie Sumers Quarry. This quarry is on the Lemons Mill Pike, 2½ miles southeast of Georgetown. It is a new quarry, opened in 1921, and the stone is used for road work.

6. Cane River Quarry. This quarry is near Cane River on the farm of Felix Swope, 2½ miles southwest of Georgetown. It has a crusher of about a 100-ton capacity.

7. J. W. Osborne Quarry. This quarry is on the Dixie Highway, 3 miles north of Georgetown. The rock is gray in color and very shaly. It is a poor road stone.

8. Dr. F. F. Bryan Quarry. This quarry is situated 3½ miles east of Georgetown. It is operated by the Frankfort and Cincinnati Railroad. The quarry is shaly on the top, gray and thicker bedded near the middle of the quarry, with the lower part of the quarry massive and thick bedded. It has a possible working face of 3,000 feet in length, and a height of 100 feet. It is a fine quarry.

9. Stamping Ground Quarry. This quarry is situated one-half mile west of the Stamping Ground Station on the Frankfort & Cincinnati Railroad, 9 miles northwest of Georgetown. It is in the blue limestone and used for road work.

10. Gaines Quarry. This quarry is on the Iron Works pike, 4 miles south of Georgetown, and about 1 mile south of Donerail in Fayette County. It is inactive, but not exhausted.

11. Anderson Brown Quarry. This quarry is on the Frankfort pike, 3 miles west of Georgetown. The length of the quarry is 150 feet, the breadth is 5 feet, and the height of the working face is now 20 feet. It has a rock crusher of 150 tons capacity. There is but little stripping to do, and water is nearby for the boiler. It is the best quarry in the county.

Shelby County.

The limestones as a rule are thinner bedded than they are in the heart of the Bluegrass region. They are gray or bluish gray in color. They are fine grained and even textured. According to W. M. Linney, stone was quarried in this county prior to 1880. The stone was used in part for road construction.

1. This quarry is near Shelbyville. The stone has been used for foundations, curbing, etc.

2. Harrisonville Quarry. This quarry is in the extreme eastern portion of the county in the more massive and thicker bedded Cynthiana limestone. Rock was quarried here prior to 1880.

3. There is a small quarry on the right of the road from Frankfort to Shelbyville, near the Shelby-Franklin County line. The limestone is shaly at the top, but thick bedded at the bottom. The stone was used in road work. The quarry is now idle. Around Eminence and Shelbyville there is but little good road building material.

Spencer County.

The limestones of Spencer County are rather thin bedded and intercalated more or less with shale. They are gray and bluish gray in color, and fine grained. Some of them are microcrystalline.

1. Taylorsville Quarry. This quarry is situated a little to

the northwest of Taylorsville. It furnishes good stone for macadam.

Trimble County.

The thicker and more massive limestone beds of Trimble County are of gray and bluish gray color and furnish good stone for road work.

1. One quarry exists about 4 miles south of Bedford which furnishes a road building stone for local use.

Washington County.

The limestones of Washington County are of gray, bluish gray, and dark gray color. They are fine to medium grained, granular to micro-crystalline, medium to thick bedded, and weather white. They have been quarried for many years and used for abutments, bridges, culverts, curbing, railroad ballast, and macadam.

1. John Hall Quarry. This quarry is also known as the McElroy quarry. It is situated at the east end of Main Street, and within the city limits. The stone is massive, light gray in color, and was used in street work in Springfield.

2. County Quarry. This quarry is 1½ miles east of the courthouse on the left hand side of the pike. The stone is used for macadam.

3. There is a quarry also on the right hand side of the pike, almost directly opposite No. 2. The stone is used for macadam.

4. Pottsville Quarry. This quarry is on the Springfield and Perryville pike, 3 miles east of the courthouse. It contains some very good bluish gray micro-crystalline limestone.

5. County Quarry. This quarry is situated 12 miles east of the courthouse. The stone is used for macadam.

6. Valley Hill Quarry. This quarry is situated 5 miles west of the courthouse. The stone is used for macadam.

7. Thompson Quarry. This quarry is 7 miles north of the courthouse, and contains very good road stone.

8. R. Horton Quarry. This quarry is on the Willisburg pike, 2½ miles north of the courthouse. It is in road stone.

No. 5. Outline Map of Road Materials in the Blue Grass Region.

5. This quarry is on the Harrodsburg pike, 10 miles south of Versailles. The quarry is in good road building stone.

6. McCowans Ferry Quarry. This quarry is near McCowans Ferry, 3 miles southwest of Versailles.

7. Mundy's Landing Quarry. This quarry is near Mundy's Landing, on the Kentucky River. Much stone has been quarried here for constructional work.

8. Oregon Quarry. This quarry is at Oregon, on the Kentucky River, about 8 miles south of Versailles. Stone was quarried here for the lock and dam No. 6 on the Kentucky River.

9. Hampton Quarry. This quarry is on Shryocks pike, about 3 miles southwest of Versailles.

10. Joe Miller Quarry. This quarry is on the Clifton pike, 6 miles west of Versailles.

11. Baker Quarry. This quarry is on the McCrackens Mill road, 5 miles northwest of Versailles.

12. I. M. Camden Quarry. This quarry is on the Frankfort pike, about 3 miles northwest of Versailles. The stone is a road metal.

13. Crutcher Quarry. The quarry is on the Crutcher estate, 6½ miles northwest of Versailles. It is a very good quarry for both building purposes and road work.

14. This quarry is on the McCrackens Mill road, 7 miles northwest of Versailles. It is used as road metal.

15. Duckers Station Quarry. This quarry is at Duckers Station, 8 miles northwest of Versailles. The stone is used for macadam.

16. This quarry is on the Leestown pike, 12 miles north of Versailles. The quarry is in fine road stone.

17. Satlerly Quarry. This quarry is situated three-fourths of a mile east of Shryocks Ferry. It is a new quarry in fairly thick bedded, dark gray limestone. The quarry has a crusher, and the stone is considered very good for road construction.

18. A. C. Hunter Quarry. This quarry is situated about ½ mile toward Versailles from the Satlerly quarry.

19. Youngs High Bridge Quarry. This quarry is near Youngs High Bridge and on the south side of the Southern Railroad.

20. J. W. Newman Quarry. This quarry is situated about 2 miles southeast of Versailles on the Dry Ridge road.

21. Bishop Quarry. This quarry is on the Griers Creek pike, 6 miles southwest of Versailles.

22. McConnels Quarry. This quarry is on the McCowans Ferry road, 5 miles south of Versailles.

23. Wilmore Garrett Quarry. This quarry is at Garrett's, 5 miles southeast of Versailles.

24. Pinkcord Quarry. This quarry is at Pinkcord, 6 miles southeast of Versailles.

25. Thomas Curtis Quarry. This quarry is at Morlonsville, 6 miles south of Versailles.

26. Cummins Ferry Quarry. This quarry is 1 mile west of Troy and south of the Cummins Ferry road.

27. This quarry is situated about 2 miles southwest of Troy and on the Mundys Landing road.

28. H. Fields Quarry. This quarry is 2 miles east of Versailles and south of the Southern Railroad.

29. This quarry is about 3 miles northeast of Versailles and midway between the Mt. Vernon road and the Southern Railroad.

30. Theo. Morris Quarry. This quarry is on the Frankfort-Lexington pike, 4 miles northwest of Versailles.

31. James Stocks Quarry. This quarry is on the Midway road, 5 miles north of Versailles.

32. W. E. Simons Quarry. This quarry is 1 mile west of the Midway road and some 6 miles north of Versailles.

33. This quarry is 7 miles northeast of Versailles and just south of the old Frankfort-Lexington road.

34. Welsen Bags Quarry. This quarry is at the east end of the Craigs Mill road.

35. Jones Quarry. This quarry is at Taylorton, 10 miles northwest of Versailles.

36. Roasch Quarry. This quarry is about 1 mile south of Midway.

37. Orphans School Quarry. This quarry is about 1 mile east of Midway.

38. Donovans Bridge Quarry. This quarry is at Donovans Bridge, 12 miles northeast of Versailles.

39. Bridge Quarry. This quarry is at the bridge over the Elkhorn River, about midway on the northern Woodford-Scott County lines.

No. of County	Name of County	No. of Quarries in County
37	Anderson	8
38	Bath	3
39	Boone	1
40	Bourbon	10
41	Boyle	10
42	Bracken	3
43	Bullitt	5
44	Campbell	4
45	Carroll	3
46	Clark	24
47	Fayette	38
48	Fleming	24
49	Franklin	11
50	Gallatin	1
51	Garrard	2
52	Grant	1
53	Harrison	10
54	Henry	10
55	Jefferson	19
56	Jessamine	8
57	Kenton	3
58	Lincoln	4
59	Madison	4
60	Marion	16
61	Mason	35
62	Mercer	6
63	Montgomery	25
64	Nelson	17
65	Nicholas	10

No. of County	Name of County	No. of Quarries in County
66	Oldham	2
67	Owen	5
68	Pendleton	8
69	Robertson	1
70	Scott	11
71	Shelby	3
72	Spencer	1
73	Trimble	1
74	Washington	11
75	Woodford	39
	Total number of quarries	397

CHAPTER VII.

THE MISSISSIPPIAN PLATEAU.

The Mississippian Plateau embraces Central, Southern and Western Kentucky. The area extends southward from the Bluegrass region to the Tennessee line. It also bounds the western coal measures on the east, south and west. Grayson and Edmonson counties, whose terranes are about equally divided between the Mississippian and the Pennsylvanian formations, are included here, for these counties are not distinctively in the western coal measures. The terranes described in this chapter are essentially limestones. Exceptions will be noted as they occur.

Adair County.

The road building rocks of Adair County are all limestones. In color they range from gray to bluish gray, and in texture from medium to coarse grained.

1. Trabue Quarry. This quarry is 1½ miles west of Columbia. The color of the stone varies from blue to bluish gray. The thickness of the individual beds varies from 6 inches to 2 feet. The stone has been used in Columbia for macadam.

2. According to L. O. Taylor, Accountant of Department of Public Roads, Frankfort, Ky., this quarry is situated near the city limits of Columbia. It is massive, thick bedded, well crystallized, and of dark gray color. The stone is being used in the concrete foundations for the new Bank of Columbia and other buildings in Columbia. It is also used for macadam. The sample submitted to the author is a good road building stone.

3. This quarry is situated 15 miles south of Columbia. The stone is yellowish white in color. This stone caps the knobs in the southern part of the county.

Allen County.

The road building rocks of Allen County are all limestones. They are of light gray, gray, and bluish gray colors. In texture

they are fine to medium grained. They have not been quarried extensively, but they should furnish a very satisfactory road metal.

1. This quarry is situated in the ravine one-half mile west of Scottsville. The stone is drab in color, fine grained, and rather soft. It contains nodules of chert, a chalcedonic variety of quartz, which injures the value of the stone somewhat for constructional work. The softness of the stone lowers its value as a road stone. It has, however, been used in base courses, underpinnings, culverts, bridges, abutments, and macadam.

2. This quarry is situated one mile southeast of Scottsville, just off the Holland pike. The quarry is much larger than the one to the west of Scottsville. A considerable amount of stone has been removed and used largely as road metal. The quarry has a crusher with a capacity of 100 tons per day.

Gravel: Good gravel deposits occur on Barren River for road surfacing.

Barren County.

The terranes of Barren County are essentially all limestones. The bluish gray, gray, and often dark gray compact limestone makes a far better road building stone than the white oolitic limestones, the chalcedonic Fort Payne formation, and the Mexican onyx.

1. City Quarry. This quarry is situated within the city limits on the northwest side of the city of Glasgow. The quarry opening is 200 feet in length, 100 feet in breadth and 50 feet in the height of the working face. The quarry has a crusher with a capacity of 100 tons per day. The individual beds vary from 1 to 8 in thickness. The thicker beds are of medium to coarse grained texture, with perfect rift and grain. They vary in color from light gray, medium gray, to a chocolate brown or reddish color, and are well crystallized. The stone is susceptible of a good polish. The polished surface suggests some of the cedar marbles of Tennessee. A large polished sample of the Glasgow marble can be seen in the museum of the Kentucky Geological

Survey. The stone is well suited for abutments, bridges, culverts, retaining walls, curbing and road work.

2. Thomas Dickinson Quarry. This quarry is situated on the Jackson Pike, 2 miles north of Glasgow. The limestone here is compact, in part oolitic, thick bedded, of medium gray color, and well suited for road building purposes. This quarry was inactive.

3. Harvey Quarry. This quarry is on the Jackson Highway, 3½ miles north of Glasgow. The quarry opening was small, for it was just being opened for use on the Jackson Highway. A study of the surrounding outcrops and topography revealed the possibility of a very large quarry at this site. The stone is compact, thick bedded, rather dark gray color, well recrystallized, traversed by stylolites, and is an excellent road stone.

4. This quarry is on the Jackson Highway, 9½ miles north of Glasgow. The individual beds vary from 2 to 5 feet in thickness. The rift and grain are perfect. The stone is of white to very light gray color, oolitic, and has been used in road construction.

5. Matthews Quarry. This quarry is situated at Temple Hill, approximately 8 miles southeast of Glasgow. The stone is dark gray in color, massive, thick bedded, and well crystallized. It is a good road stone, and agricultural stone.

6. John Owens Quarry. This inactive quarry is situated 1½ miles north of Cave City, near the Hart County line. This quarry, which assumes the aspect of a mining prospect, is in Mexican onyx. Blocks of onyx marble have been obtained here 5 feet in length, 2½ feet in breadth, and 2 feet in thickness. The stone is translucent, banded with beautiful colors, and susceptible of a high polish. It is not a road stone.

7. E. Ford Quarry. This inactive quarry is situated three-fourths of a mile west of Cave City. The opening is in Mexican onyx. Blocks of onyx marble have been obtained here 4 feet in length, 2½ feet in width, and 16 inches in thickness. A part of the onyx is very white and banded, and a part of it is a sienna yellow and partially recrystallized. It is not a road stone.

8. Show Quarry. This quarry is one-fourth mile off the Mammoth Cave road. According to S. S. Garby, blocks of Mex-

ican onyx have been obtained here that were 6½ feet in length, 4½ feet in width and 2½ feet in thickness, and 11,000 pounds of the stone has been shipped to Louisville for decorative interior work. It is not a road stone.

9. According to S. S. Garby, there is a possible quarry in Mexican onyx on land owned by E. Ford, 2 miles southwest of Cave City on the Dixie Highway. Mr. Garby states that solid blocks of red Mexican onyx can here be secured as large as a railroad car. The property was not visited by the author. The stone cannot be a good road metal.

Breckinridge County.

The limestones of Breckinridge County are light gray, gray, and bluish gray in color, fine to medium grained, massive, and thick bedded. The Hardinsburg sandstone splits readily into slabs suitable for flagging purposes.

1. This quarry is situated on the Ohio River, on the Louisville, Henderson & St. Louis Railroad, about 1 mile east of Cloverport. The limestone is bluish gray and thick bedded. It is in the Glen Dean formation. The stone is used for macadam.

2. Beard Brothers Quarry. According to P. M. Bashun, County Judge, this quarry is at Hardinsburg. The stone has been used for foundation work in Hardinsburg.

3. S. W. Davis Quarry. This quarry is situated at Mystic, a small station on the Louisville, Henderson & St. Louis Railroad, about 10 miles north of Hardinsburg. The quarry is in the Fredonia member of the St. Genevieve oolitic limestone. It is used for railroad ballast and road work.

4. Webster Stone Company Quarry. This quarry is at Webster, a station on the Louisville, Henderson & St. Louis Railroad, some 10 miles northeast of Hardinsburg. The stone is used for railroad ballast, road metal, and agricultural lime.

5. This quarry is situated about 1 mile south of Sinking Creek, on the Fordsville Branch of the Louisville, Henderson & St. Louis Railroad. The top of the quarry is in a dark gray, siliceous, oolitic limestone, Gasper, in which there are many small granules of quartz about 1 millimeter in diameter. The bottom of the quarry is in a siliceous limestone containing numerous rounded pebbles of an oolitic limestone. The stone is used for railroad ballast and macadam.

6. Irvington Quarry. This quarry is at Irvington in the Gasper oolitic limestone. The length of the quarry is 150 feet, the breadth 100 feet, and the height 90 feet.

Rock Asphalt: Several deposits of rock asphalt were examined in Breckinridge County. These deposits consist of a fine grained, porous sandstone more or less impregnated with asphaltic material. The sand is finer grained than in Grayson and Edmonson counties. It is also finer here than in Carter County in the northeastern part of the State. The asphalt content in general is low.

(1) Little Tar Spring. This deposit is on the Ohio River, within 50 feet of the Henderson and Louisvile Railroad, 200 feet north of the Louisville-Paducah pike, and 3 miles west of Cloverport. Tar oozes from the fine grained sandstone around the spring, but there is no positive proof that the rock asphalt occurs in a merchantable quantity.

(2) This deposit is on land owned by Mrs. Olive Brockly, ¼ mile south of the southwest corner of Cloverport. It is also on the Breckinridge & Cannel Coal Railroad right of way. This railroad is now abandoned. A small opening has been made in the asphalt deposit. Tar drains out of the rock into a little pool. The depth of the deposit is unknown. The acreage of this deposit was estimated by Paul Lewis, Breckinridge Bank of Cloverport, as 350 acres. The thickness of the asphalt can only be determined by more drilling or sinking shafts. This outcrop was sampled, but the sample failed to pass the State requirements.

(3) Tar Springs. 500 acres are estimated around Tar Springs to carry rock asphalt. There is 4 or 5 feet of this rock asphalt at the base of Sandstone Cliffs some 75 feet in height. This field has not yet been proven.

(4) Garfield. The acreage for rock asphalt at Garfield is ample. Quite a little development work has been done and good road building rock asphalt obtained. The property is idle and said to be tied up by litigation.

Gravel: (1) Gravel deposits occur at McQuady. The gravel is brown in color with clay and iron oxides as the cement-

ing materials. It has been used in road construction with good satisfaction.

(2) River Gravel. This has been dredged from the Ohio River just above Addison, 7 miles east of Cloverport.

Caldwell County.

The road building stones of Caldwell County are essentially limestones. These are white to grayish white in color, fine grained, even textured, oolitic limestones of the Freedonia formation. The oolites are mostly round, but some of them are elongated. The limestone is often traversed by narrow zigzag bands of darker material that give striking contrasts on the polished surfaces.

1. Katterjohn Quarry. This quarry is operated by the F. W. Katterjohn Construction Company, and the output largely used by the Illinois Central Railroad. The quarry is situated 3 miles southeast of Princeton at Cedar Hill. The length of the quarry is 1,000 feet, the breadth is 300 feet, and the maximum height of the working face is 200 feet. The quarry was opened in 1902. The upper part of the quarry is in the Ohara limestone and the lower part in the Freedonia limestone. Both formations belong to the St. Genevieve stage of the Mammoth Cave limestone series.

The capacity of the crusher at this plant is 1,500 tons per day. Five different sizes of stone are produced: No. 1 is 2½ inches in diameter: No 2 is 1½ inches in diameter; No. 3 is 1¼ inches in diameter; No. 4 is ⅝ inch in diameter, and No. 5 is ¼ inch in diameter to dust.

Beneath the floor of this quarry there is a 20-foot bed of massive, fine grained, light gray to nearly white oolitic limestone. This limestone, on account of its freedom from iron, its whiteness of color, its oolitic uniform texture, its perfect rift and grain, would make a good road building stone. The opening in this bed is in the left hand corner of the quarry. A hand sample was collected here that is traversed by a narrow vein of fluorite.

2. E. Boaz Quarry. This quarry is on the Princeton and Cadiz pike, 3 miles south of Princeton. This quarry was opened several years before the Civil War.

3. M. U. Lamb Quarry. This quarry is situated on the Hopkinsville and Eddyville pike, 4 miles southwest of Princeton. The stone was used in the construction of the pike. Both the white and blue limestones occur here.

X QUARRY OF THE F. W. KATTERJOHN CONSTRUCTION COMPANY. This quarry is situated near Princeton, Caldwell County, Ky. It shows the thickness of the white oolitic layer towards the top of the quarry.

4. W. F. Holman Quarry. This quarry is situated about 1¼ miles northeast of Princeton and about three-fourths of a mile from the Illinois Central Railroad. The quarry opening is about 150 feet in length. This quarry is in a very friable sandstone. The lower 30 feet of this sandstone is white or nearly white in color, fine to medium grained, with the individual sand grains rounded to subangular in shape. The upper 20 feet is iron stained on the surface, but yellowish white when broken. The most of the stone quarried here has been used in the manufacture of mortar and cement. The stone is too friable for road work.

5. Thomas Young Quarry. This quarry is situated 1 mile northeast of Princeton. It is now owned by W. F. Holman. The stone is approximately identical with that in No. 4, and has been used for the same purposes.

6. To the north of Princeton sandstone from small local

quarries or prospects has been used for abutments of bridges, and for culverts. Some of these northern sandstones are fine grained, of yellowish brown color, and weather a yellowish brown. Others are coarser in texture, and weather reddish brown.

Casey County.

Many of the limestones of Casey County are of gray, bluish gray, and dark gray color, certain beds of which could furnish good road building stone. It is not known that stone has ever been quarried in this county.

Christian County.

The terranes of Christian County are prevailingly limestones. The most of them are white or grayish white in color, and relatively pure limestones. Some of them have been extensively quarried and the product used largely by the Louisville & Nashville Railroad.

1. Cooks Stone Company Quarry. This quarry is situated just outside the city limits of Hopkinsville. It is about 500 feet in length, 100 feet in breadth, and the height of the working face is approximately 60 feet. It has a rock crusher with a capacity of 150 tons per day.

Most of the stone in this quarry is white to grayish white and oolitic. The oolites are mostly round, but a few of them are elongated. It is remarkably free from iron and weathers white. It is a fine grained, semi crystallized, thick bedded, and traversed by a few very narrow zigzag bands of a darker hue. The thicker beds reach a maximum of 10 feet. It works easily and breaks with a conchoidal fracture. In the lower part of the quarry there is a drab to dark gray limestone bearing a few flint nodules.

2. W. S. Davidson Quarry. This quarry is situated inside of the corporate limits, a little ways off the Louisville & Nashville Railroad, and is operated by the city of Hopkinsville. The stone is excellent for road work.

3. County Quarry. This quarry is on the Dawson highway, 1 mile west of Hopkinsville. The quarry is 125 feet in length with 22 feet of good road stone beneath a heavy overburden of soil and shale. This quarry may be abandoned on account of the heavy overburden.

4. Fannieville Quarry. This quarry is on the Dixie B. highway, 6 miles southeast of Hopkinsville. The length of the working face is 100 feet. The height is 20 feet. The overburden is 4 feet. The stone meets the State requirements.

5. J. T. Edmunds Quarry. This quarry is on the Clarksville pike, 3 miles south of Hopkinsville. The stone is good but the quarry is now idle.

6. J. Stevenson Quarry. This quarry is on the Dover road, 11 miles south of Hopkinsville. The stone meets the State requirements.

7. R. S. Gary Quarry. This quarry is on the Cokes Mill road, 5 miles off the main road. It is a good road stone.

8. J. Johnson Quarry. This quarry is 4½ miles north of Hopkinsville on the Dixie B. highway. The overburden is heavy and therefore it is too expensive to operate the quarry.

9. This quarry is on the Canton road 5 miles west of Hopkinsville. The quarry is 100 feet in length, and the height of the working face is 20 to 25 feet. It was opened in 1922, and the stone is very good.

10. This quarry is on the Butter road 9 miles northeast of Hopkinsville. The quarry face is 75 feet in length and 12 feet in height. A part of the stone is good and a part very soft. This makes the quarry unsatisfactory.

11. Cates Mill Quarry. This quarry is on the Nashville pike about 50 yards east of the city limits. The stone is good, but the quarry is idle.

12. J. H. Holman Quarry. This quarry is 1½ miles east of Hopkinsville and ½ mile south of the Nashville road. The stone is good.

According to J. H. Dillman, County Road Engineer, 9 miles of road between Hopkinsville and Gracey is now being built of gravel from Gravel Switch, Kentucky. The road passes two of the best quarries in the county each of which meets the State specification.

Gravel: There is no gravel in merchantable quantity in Christian County north of Hopkinsville, but in the southern

part of the county there is a little soft gravel that has been used on a macadam surface and on a sandstone base.

Crittenden County.

The terranes of Crittenden County are widely varied in composition and origin. Many of the sandstones are too soft and friable for road work. The peridotite dikes of igneous origin are too narrow to operate economically. The limestones can furnish good road metal.

1. Lemuel Clark Quarry. This quarry is about three-fourths of a mile east of the courthouse on the farm owned by Lemuel Clark and his son. The quarry is in a sandstone, which is pure white or yellowish white in color, and very friable. The product has been shipped to Evansville, Indiana, for manufeature of glass. It has been used in the manufacture of brick for consumption around Marion, and as a building sand. It is too friable for road work.

2. Dr. O. C. Cook Quarry. This small quarry is about 20 rods north of the Second Baptist Church of Marion. The stone has been used for base courses, curbing, paving, and flagging. It is not a good stone for road work.

3. Nunn Quarry. This quarry is situated near Nunn Station, 5 miles due north of Marion. The quarry is in limestone and the product used for abutments, bridges, culverts, etc.

4.-9. According to G. C Appleton, Division Engineer, Paducah, Kentucky, there are six quarries on the Marion-Smithland pike, now being constructed in Crittenden County for a distance of 11 miles. They are all in sandstone, and all pass the State requirements for cement rubble.

No. 4 is ¾ mile west of Marion
No. 5 is 3 miles west of Marion
No. 6 is 4 miles west of Marion
No. 7 is 6 miles west of Marion
No. 8 is 8 miles west of Marion
No. 9 is 10 miles west of Marion

10. This is a quarry possibility in limestone 5 miles southeast of Marion and ½ mile northwest of Crane Station. The overburden is rather heavy.

Gravel: Good road building gravel occurs 7½ miles southwest of Marion and ¼ mile south of station 10150.

Cumberland County.

The road building stones of Cumberland County are bluish gray and blue limestones. The hard, thick bedded layers along the Cumberland River should furnish good road building stone for local use. A quarry was reported to furnish stone for work in Burkesville.

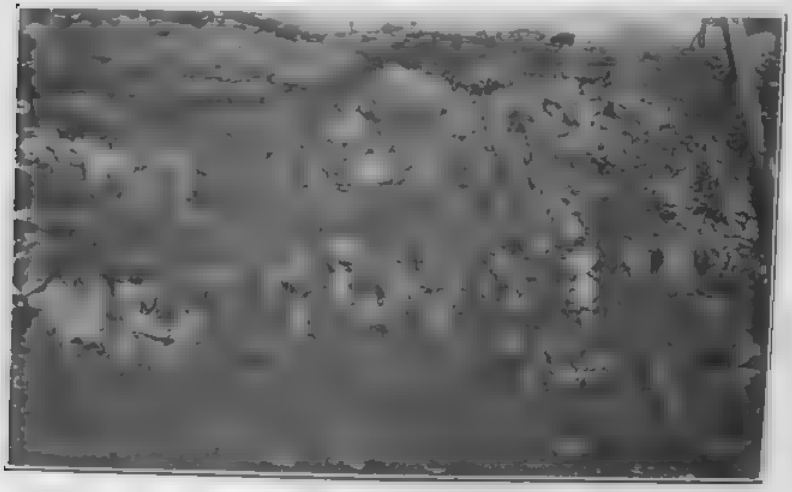
Edmonson County.

The limestones of Edmonson County are white, light gray, gray, and dark gray in color. They are medium grained and coarse grained. They are mostly oolitic. Some of them are very compact, with vitreous luster, and break with a conchoidal fracture. They are thick bedded and can produce good road building stone.

1. One quarry exists near Brownsville. This has furnished a small amount of stone for local use. The quarry is in oolitic limestone.

Rock Asphalt: Porous sandstones impregnated with bituminous substances mostly asphalt—and asphalt is a viscous bitumen—are especially abundant in Edmonson County. The finished product is the ideal road surfacing material. The supply in Edmonson and Grayson counties is ample to hard surface every road in the State of Kentucky.

(1) Kentucky Rock Asphalt Company. The quarries and the mill are located at the village of Kyrock on Nolin River in the central part of the county. The asphalt is here quarried rather than mined. For open cut work 20 to 40 feet of stripping is required. The asphalt deposit itself varies in thickness from 20 to 40 feet. The length of the working face is estimated as one mile. The ore is hauled by small trains to the mill, which is the largest and best equipped asphalt mill in the State.

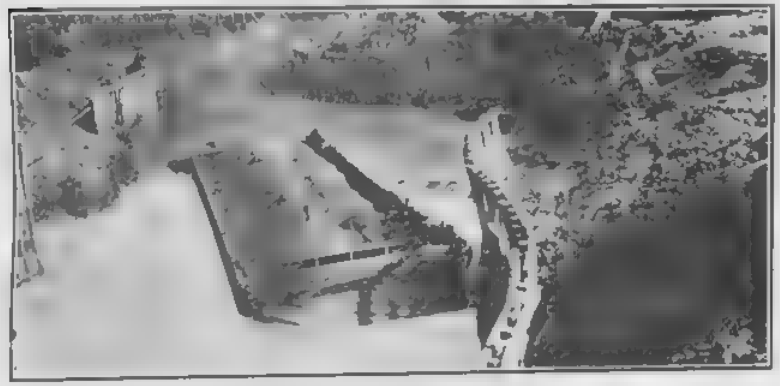


27. ROCK ASPHALT BROKEN DOWN BY BLASTING.
This quarry is at Kyrock, Edmonson County, Ky.

The coarse crusher handles blocks of rock asphalt weighing from 3 to 5 tons. From the crusher the rock goes to a smaller crusher, then through screens, coarse adjustment rolls, medium adjustment rolls, fine adjustment rolls, belt conveyor to barge, and by barge down the Nolin and Green Rivers and thence up the Big Barren River some 70 miles to Bowling Green. 5/6 of the product is estimated as waste. The capacity of the

28. QUARRY OF THE KENTUCKY ROCK ASPHALT COMPANY.
This quarry is at Kyrock, Edmonson County, Ky. The material on the left contains less than 7 per cent asphalt. It is a rock asphalt reserve.

mill is 1,200 tons of finished product per day. The sand in this rock asphalt is a little coarser than in Grayson County. The volatile matter averages between 7 and 7.5 per cent with an average of actual bitumen of 6.2. The rich asphalt meets the State requirements.



29. BARGE LOADED WITH PULVERIZED ROCK ASPHALT.
This barge is on the Nolin River at Kyrock, Edmonson County, Ky. The asphalt is shipped to Bowling Green for storage.

2. This group of properties is situated on the south side of Green River, just east of the Warren County line and near Watts School. An analysis of samples from these properties made by Dr. A. M. Peter, Experiment Station, Lexington, Ky.,

30. KENTUCKY ROCK ASPHALT READY FOR SHIPMENT.
The asphalt belongs to the Kentucky Rock Asphalt Company, Kyrock, Edmonson County, Ky. The entire pile is said to contain 200,000 tons of crushed asphalt. It is situated at Bowling Green, Ky.

gave Cherry farm 8.49 per cent volatile matter, Doyle farm 7.33 per cent volatile matter, Keowan farm 8.25 per cent volatile matter.

3. The Marion-Klefiield, et al., properties comprise 7,410 acres in Edmonson and Grayson counties and 1,320 acres in Henderson and Union counties. The former properties are between Deckers Mill and Goff post office. Average thickness of asphalt, 8 to 10 feet. No analyses are available.

4. B. F. Miller and R. A. Bashan Properties. These farms join the properties of the Natural Rock Asphalt Company on the west. They are, furthermore, on Bear Creek. The asphalt is 18 feet or less in thickness. One analysis gave 8.05 of volatile matter.

5. The Overall and Owen properties are situated along a small branch of Green River and on the east side of Bear Creek. 1,200 acres are involved with rock asphalt ranging from 2 to 50 feet in thickness with an average thickness of 15 feet. This depth is ascertained from a series of core drillings and about 50 pits. The volatile matter ranges from 6.70 per cent to 10.40 per cent. The finished product could be shipped by barge to Evansville, Indiana, or to Bowling Green, Kentucky, or to Rockport on the Illinois Central Railroad.

6. Natural Rock Asphalt Properties. These properties are situated to the north of the Overall and Owen properties and on Bear Creek. The main office is in Greenville, Kentucky. The company is operating a mill with a capacity of 250 tons per day.

7. The Rock Asphalt Company of America controls 2,026 acres north of Pittsburg Ferry and on Green River, 2 miles west of Brownsville. An analysis of this asphalt gave 10.70 per cent volatile matter. The deposits vary from 10 to 15 feet in thickness.

8. The properties of the Wordsworth Stone and Mining Company are ½ mile south of Asphalt post office, north of Davis Ferry, and north of Green River. No analysis is available.

Grayson County.

The terranes of Grayson County comprise both limestones and sandstones. The limestones are white, gray, and bluish gray

in color, and weather white. They are fine to medium grained, and some of them are thick bedded. The sandstones are yellowish white to white, and weather a yellowish white to a reddish brown. Both the limestones and the sandstones have been quarried and used for abutments, bridges, curbing, and macadam.

1. W. J. Cunningham Quarry. This quarry is situated one-half mile southeast of Leitchfield. The quarry is 250 feet in length, 50 feet in depth, with a height of working face of 15 feet. The quarry is in a hard, bluish gray, tough limestone, that breaks with an angular fracture. The product is used by the county in road building, and is considered a very good road stone.

2. Polly Owens Quarry. This quarry is one-fourth mile southwest of the courthouse. The rock is limestone.

3. Berry Quarry. This quarry is one-fourth mile northeast of the courthouse. The quarry is in limestone.

4. R. L. Morman Quarry. This quarry is 1½ miles west of Leitchfield. The quarry is in limestone.

5. W. O. Jones Quarry. This quarry is 1 mile northwest of the courthouse. The quarry is in sandstone.

6. L. Decker Quarry. This quarry is one-fourth mile southeast of the courthouse. The quarry is in sandstone.

7. George Meredith Quarry. This quarry is 1 mile east of the courthouse. The quarry is in limestone.

8. Lile Quarry. This quarry is on the Elizabethtown pike, 2 miles east of the courthouse. The quarry is in limestone.

9. Hardin Porter Quarry. This quarry is at Yeaman, 18 miles west of the courthouse. The quarry is in limestone.

10. John White Quarry. This quarry is 2 miles north of the courthouse. The quarry is in limestone.

11. Charles Stenson Prospect. On the farm of Charles Stenson, 1 mile northwest of the courthouse, there is a bed of very white, fine grained, oolitic limestone.

12. James Cook Prospect. On the farm of James Cook at Meredith, 5 miles south of Leitchfield, there is a sandstone that is even bedded, and works easily into small dimension blocks, but it is better suited for the manufacture of home stones.

13. Illinois Central Quarry. This quarry is situated 2

miles north of Grayson Springs, near the Illinois Central Railroad. The individual beds of gray limestone are 4 feet in thickness.

Rock Asphalt: There are several rock asphalt properties in Grayson County. Some of these are producers. Others need

31. QUARRY OPENING IN ROCK ASPHALT.
This quarry is in Grayson County, Kentucky, within a few miles of Leitchfield.

careful core drilling and many analyses before their correct value as road surfacing material can be determined.

(1) Crown Rock Asphalt Company. This is at Big Clifty. The company operates a mill the capacity of which is unknown to the author. No analyses are available.

(2) Continental Rock Asphalt Company. This company

also has a mill at Big Clifty with a capacity of 300 tons per day. The mine is situated 3½ miles west of the mill. The opening at the mine and quarry are a unit and extend some 500 feet in length from the outermost drifts. The thickness of the merchantable asphalt ranges from 4 to 5 feet. The content of volatile

32. TEST PIT IN ROCK ASPHALT.
This pit is situated on the Meredith Dome, Grayson County, Ky.

matter ranges from 7 to 8 per cent. The richest rock has run as high as 10 per cent, but the poorer rock has fallen as low as 4 per cent in volatile matter.

(3) Meredith Hill Properties. These properties are situated on what is known as the Meredith Dome 8 miles southeast of Leitchfield. On the J. H. Williams farm, 1 mile southeast of Meredith, there is an opening from which 40 to 50 tons of rock asphalt has been quarried, but none shipped. The supply appears ample from the study of 100 feet of working face. The asphalt is about 9 feet in thickness. On the Charles Hoffman farm the asphalt is 25 feet in thickness as determined by 2 openings. At the opening on the Tom Stevenson farm the asphalt is 25 feet in thickness. A quarry could be opened here with working face of 1,500 feet and but little stripping.

(4) Silica Asphalt Company of Moline, Illinois, own the

Annetta Dome properties which have had some work done upon them, and are reported to carry good asphalt. They are situated some 2 miles from the Meredith Dome properties and south of Leitchfield.

5. Black Rock Asphalt Company. This company owns somewhat extensive properties, 2,222 acres, around Church, Kentucky, which is about 3 miles southeast of Black Rock, a station on the Illinois Central Railroad. Some core drilling has been done on the Church properties. The average thickness of asphalt on the Church properties is 9 feet. On several farms the overburden is light. A large number of analyses have been made which show an average of 7.11 per cent volatile matter. A special sample from the Spence farm gave 26.04 per cent volatile matter, and one from the George Hack farm showed 77 per cent volatile matter. On the James Downs farm the asphalt is 32 feet in thickness with average of five analyses showing 7.4 per cent asphalt or volatile matter.

Green County.

The possible road building rocks of Green County are limestones of light gray, gray, bluish gray, and dark gray color. Good road building stone should be found in the Mammoth Cave limestone series.

1. This quarry is in the Mammoth Cave series near Greensburg, and has furnished stone for local use around Greensburg.

Hardin County.

The road building stones of Hardin County are essentially limestones. They are of white, light gray, gray, and bluish gray colors. Some of them are fine grained, some are medium grained, others are coarse grained and oolitic. Usually they are thick bedded, and weather white.

1. McMurtry Quarry. This quarry is situated just outside the city limits of Elizabethtown on the east side of the city. The quarry is in thick bedded limestone. It represents a good road stone.

2. Government Quarry. This quarry is on the Dixie Highway, 4 miles south of West Point. The quarry is 100 feet in length, 40 feet in breadth, with height of working face 40 feet. The individual beds are from 2 to 4 feet in thickness. It is an excellent road stone.

3. West Point Quarry. This quarry is at West Point on the Illinois Central and Louisville, Henderson & St. Louis Railroads. The stone has been used largely in railroad construction, but the quarry is now inactive because the stone is regarded as too soft for road construction. The quarry has a working face of 100 feet.

4. Silman Stone Quarry. This quarry is on the Illinois Central Railroad at J. 51, 1 mile south of Stephensburg. The length of the quarry is 1,350 feet, the breadth is 400 feet, and the height of the working face is 62 feet. A section in this quarry gave the following thickness:

10 feet bluish gray crystalline limestone top.
3 feet grayish white marble, well crystallized.
12 feet gray limestone.
14 feet bluish gray hard limestone.
5 feet magnesian limestone.
8 feet white to buff limestone.

The 14-foot bed of hard, bluish gray limestone is called by the quarrymen "Bell metal rock" because it rings under the hammer. It is very massive and breaks with a conchoidal fracture. It is regarded as the best road stone in the quarry. The quarry was opened in 1912 and has been in continuous operation ever since. It carries a crusher with a 450-ton daily capacity. The stone is used by the Illinois Central Railroad for abutments, bridges, and ballast, and by Hardin County and Camp Knox in the construction of permanent roads.

5. J. C. Hix Quarry. This quarry is situated 1 mile west of Stephensburg, with road bed and right of way owned by the Illinois Central Railroad. The stone is very good for road building purposes.

6. Brown-Goodin Company Quarry. This quarry is at Upton, on the Louisville & Nashville Railroad, in the extreme southern part of the county. It is a very large quarry, and the product is used by the Louisville & Nashville Railroad.

Rock Asphalt: (1) The Ohio Valley Rock Asphalt Company operates a large plant for the manufacture of rock asphalt at Summit, on the Illinois Central Railroad. The rock asphalt deposits are only a few rods south of the station and on the east side of the railroad. The mining is done by stripping and the overburden is light. The deposit averages about 6 feet in thickness and analyses show from 7 to 8 per cent volatile matter. About 6 acres have been stripped to the asphalt bed.

(2) At Millburne Hill there is an asphalt property with asphalt 9 feet in thickness. This may be catalogued as an asphalt reserve.

Hart County.

The road building stones of Hart County are chiefly the coarsely oolitic, thick bedded, Freedonia limestone, and the oolitic Gasper limestone. According to Charles Butts, the numerous bluffs visible from the Louisville & Nashville Railroad between Russellville and Elizabethtown are in the Gasper oolite.

1. Munfordville Quarry. This quarry is situated on the east side of the Louisville & Nashville Railroad, 4 miles north of Munfordville, the county seat. The quarry is 150 feet in length, 100 feet in breadth, and the height of the working face is 90 feet. The upper 10 feet of the quarry is in a yellowish white, much decomposed limestone. The remainder of the quarry is in the white, oolitic, Gasper limestone. It is rather soft, works easily. It is largely used in road construction.

2. Hammonville Quarry. This quarry is in road stone near the boundary between Hart and Larue counties, northeast of Hammonville.

3. Pilot Knob Quarry. This quarry is situated 20 miles due east of Horse Cave. The quarry is in Mexican onyx or onyx marble. It is not a good road stone.

4. Dan Carpenter Prospect. This possibility of a Mexican onyx quarry is situated just outside the corporate limits of Horse Cave and about 10 rods to the right of the Dixie Highway on the road to the Mammoth Onyx Cave which might well be called Mexican Onyx Cave. It is not a road stone.

5. Barren River Prospect. According to C. L. Jewell of

Horse Cave there are large deposits of Mexican onyx about 20 miles from Horse Cave along Barren River. Some of these outcrops are from 20 to 30 feet in height, and beautifully banded. It is not a road stone.

6. Horse Cave Prospect. According to W. C. Gibson, Secretary of the Chamber of Commerce, Horse Cave, the largest deposits of Mexican onyx in Kentucky, are along the lines of Hart, Barren and Edmonson counties, with the best deposits in Hart County, about 3 miles southwest of Horse Cave. It is not a road stone.

Larue County.

The road building stones of Larue County are limestones. They are white, grayish white, gray and bluish gray in color, fine to medium grained, and thick bedded.

1. Tonieville Quarry. This quarry is situated at Tonieville, 6 miles northwest of Hodgenville. It can furnish good road building stone.

2. Walter Lane Quarry. This quarry is at Buffalo, 5½ miles southeast of Hodgenville. The stone is heavy and even bedded. There are several good quarry sites at Buffalo, and all could produce road metal.

3. Nolin Quarry. This quarry is near Nolin, and near the intersection of North Fork and South Fork of Nolin River. There is much good stone here for local use.

Livingston County.

The road constructional rocks of Livingston County comprise both limestones and sandstones or quartzites. The limestones are fine grained, gray in color, and thick bedded. The quartzose terrane is medium grained, white in color, and thick bedded.

1. Barrett Company Quarry. According to J. T. Madison, Office Engineer, Frankfort, Ky., there is a good sized quarry in the gray limestone formations 4½ miles northeast of Smithland. It is, furthermore, on the north side of the Cumberland

River. The quarry product is largely sold to the United States government for the construction of locks and dams.

2. Quarry Prospect. This prospect is located 3 miles south of Smithland. The prospect has a good working face of from 20 to 30 feet. The rock is practically pure white to a faintly yellowish white, medium grained quartz sand recemented by pure quartz, and therefore a quartzite. It is the hardest and most resistant rock known in the State. The original sandstone may have been converted into a quartzite along fault lines through the influence of rock movements due to faulting. The area is extensive and well worthy of careful investigation for road metal.

3. Old Quarry. This quarry is situated in the gray limestone 4 miles northeast of Smithland. The face of exposed limestone is some 2,000 feet in length and about 20 feet in height. The quarry is now idle.

Logan County.

The building stones of Logan County are limestones. They are white, grayish, gray and bluish gray in color. They are fine to medium grained, even textured and thick bedded. Some of them are pronouncedly oolitic, and some are excellent road stone.

1. W. J. Sparks Quarry. This quarry is situated on the Morgantown pike, 1½ miles northeast of Russellville. In this quarry there is 30 feet of white, oolitic, thick bedded, crystalline limestone. It has fine grain, even texture, uniform color, and receives a good polish. There is also 20 feet of a very compact drab colored limestone. The output of the quarry is largely used for railroad ballast and macadam. The quarry is 500 feet in length, 400 feet in breadth, and with height of working face 40 feet.

Trapp Quarry. This quarry is on the Greenville Pike 2 miles northeast of Russellville. The quarry is 500 feet in length, 200 feet in breadth, with 20 feet of rock exposed above the water level. The depth of the water was 30 feet. The water could easily be pumped out and the quarry reworked. There is much good stone at this idle quarry.

3. Berger Quarry. This quarry is on the Hopkinsville pike, 1½ miles west of Russellville. The quarry face is 200 feet in length, 50 feet in breadth, and the height of the working face is 20 feet. The individual beds are from 4 to 6 feet in thickness, very compact, and of bluish gray color. The stone weathers a grayish white. It is regarded as a good road stone.

4. County Quarry. This quarry is on the Nashville pike, 1 mile south of Russellville. The output is used by the town and county in the construction of streets and permanent roads.

5. This quarry is situated a little to the northeast of No. 4. The stone is used for abutments, bridges, culverts and curbing.

6. This quarry is situated on the Greenville pike, 3 miles north of Russellville. It is now inactive.

7. This quarry is situated 10 miles south of Russellville. It is in the bluish gray limestone and the product is used in road work.

8. McReynolds Quarry. This quarry is situated on Muddy River 3 miles east of Lewisburg. The stone is used for macadam.

9. Asher Quarry. This quarry is 1 mile west of Lewisburg. The stone is good.

10. Milon Quarry. This quarry is 5 miles northeast of Lewisburg. The stone is used in road work.

11. Clarksville Road Quarry. This quarry is on the Clarksville road, 9 miles southwest of Russellville. The stone is used for macadam.

12. This quarry is also on the Clarksville road and about 8 miles from Russellville.

13. Rockhouse Bridge Quarry. This quarry is 9 miles north of Auburn. The stone is a very good road metal.

14. Hall Quarry. This quarry is 3 miles north of Auburn. The stone is used for macadam.

15. This quarry is 1 mile southwest of Auburn on the Auburn-Russellville road. The stone is very good.

16. This quarry is situated 15 miles southeast of Russellville. The stone is only fair.

Gravel: (1) There is an adequate supply of good gravel near Adairville on the Red River. This gravel is now being used in surfacing the roads.

(2) This gravel bed is on the Logan-Butler County line, 18 miles north of Russellville. This bank gravel ridge is nearly 2 miles in length, and the gravel averages about 12 feet in thickness.

Rock Asphalt: Sandstones more or less impregnated with a thick tarry oil were worked several years ago in a somewhat centralized area some 4 miles northeast of Russellville. Some of these deposits are known to be from 18 to 20 feet in thickness. An analysis made by Dr. A. M. Peter, Experiment Station, Lexington, Kentucky, of a three pound sample gave 7.61 per cent of bituminous matter extracted by carbon disulphide.

The American Standard Asphalt Company with main office in Eddyville, Kentucky, now controls 557 acres of asphaltic bearing land. This property is now being core drilled to ascertain the thickness and economic value of the rock asphalt near Homer.

Lyon County.

The road building stones of Lyon County are limestones. They are of medium gray to dark gray color and weather a slightly grayish white. They are medium grained to coarse grained, oolitic, thick bedded limestones. The oolitic texture is far more pronounced on the polished surface than it is in either hand samples or the quarry face. It is semi-crystallized, and the coarse aggregations of the calcite as seen on the polished face suggest a conglomerate. Some layers are traversed by zigzag bands of darker material.

1. Gen. H. B. Lyon Quarry. This quarry is situated 2½ miles southeast of Eddyville. The quarry product is a very hard, medium gray, medium to coarse grained, semi-crystalline, oolitic limestone. The quarry is some 300 feet in length, 60 feet in breadth, and with height of working face of 25 feet.

2. W. H. Long Quarry. This quarry is 1¼ miles northeast of the courthouse. It is a very massive, dark gray, semi-crystalline limestone that weathers a very light gray.

3. County Quarry. This quarry is 1 mile southeast of Eddyville. Crushed stone was obtained here for road work. The quarry is now inactive.

4. H. B. Lyon Quarry. This quarry is 3 miles southeast of the courthouse. The stone was burned for lime for constructional and agricultural purposes.

5. Coffer Dam Quarry. This quarry is situated within the corporate limits, and the stone is being used in the construction of the coffer dam.

6. Big Spring Quarry. This quarry is in the east end of Eddyville. It is now inactive.

7. Cliff Quarry. This quarry is one-half mile north of the courthouse. The stone is used for abutments, bridges, culverts and curbing.

8. C. W. Emery Quarry. This quarry, which is now inactive, is situated 1½ miles west of Grand River in a thick bedded limestone that weathers white. The stone from this quarry was used in the two large iron furnaces at Grand Rivers.

Meade County.

All the quarries in Meade County are in the limestone members of the different series. The limestones vary widely in texture from the fine grained lithographic limestone to the coarsely crystalline St. Louis limestone. In color they are drab, light gray and dark gray.

1. Lithographic Limestone Quarry. This quarry is situated about one-half mile north of Brandenburg. As the name implies, the quarry is in the lithographic limestone. The product is largely used in the preservation of stock patterns, for it lends itself readily to delicate carving. The stone is highly argillaceous. In cases of extreme weathering, it yields a clay product. The stone is not equal to the famous lithographic limestone of Solenhofen, Bavaria, yet it is in good demand and commands high prices.

2. Portland Cement Plant Quarry. The large Portland cement plant at Kosmosdale secures its limestone from a large quarry about 8 miles southeast of Brandenburg, near the Ohio River.

3. Local Quarry. According to J. Morgan Richardson, attorney-at-law, Brandenburg, there is a local quarry at Brandenburg. The stone becomes laminated upon long continued ex-

posure to the atmosphere. The stone has been used for foundations and curbing.

Metcalfe County.

The Waverlian and Mammoth Cave formations should furnish road building stone for local use. One quarry exists near Edmonton, which has furnished stone for foundations and curbing at Edmonton.

Monroe County.

1. One quarry exists in the Waverlian series near Tompkinsville. The product is used for foundations and curbing in Tompkinsville.

Russell County.

The road building stones of Russell County are limestones. The Maysville and Richmond formations of the Cincinnatian series are sufficiently thick bedded and crystalline to furnish road building stone for local use. The white, light gray and gray, thick bedded, Mammoth Cave limestone can furnish good road building stone.

1. One quarry exists near Jamestown. This quarry furnishes stone for curbing in Jamestown.

Simpson County.

The limestones of Simpson County are white, grayish white, and gray. They are often oolitic and thick bedded. They can furnish good road building stone.

1. Walter Stringer Quarry. This quarry is situated about 4 miles west of Franklin. The stone is used for foundations, abutments, bridges, curbing, and road metal.

2. This quarry is on the Blackjack road about 5 miles east of Franklin. The stone is used as road metal.

Gravel: Bank gravels were reported from Simpson County, but none of the deposits were visited.

Taylor County.

The limestones of Taylor County are gray and bluish gray in color, fine to medium grained, and sufficiently thick bedded to furnish road building stone for local use.

1. One quarry exists near Campbellsville. This quarry furnishes stone for foundation work and curbing, as well as road metal.

Todd County.

The limestones of Todd County are white, grayish white, and bluish gray in color. They are in part oolitic, medium to coarse grained, thick bedded, and can furnish good road building stone.

1. E. L. Traugher Quarry.This quarry is situated on the Russellville pike about 4 miles west of Elkton, the county seat of Todd County. The quarry is in the white, oolitic limestone. It is largely used in the construction of permanent roads.

2. There is an abandoned quarry just west of Elkton that has furnished much stone for retaining walls, fences, foundations and road work.

3. This quarry is just out of Elkton, to the east. The stone has been used in foundation work.

4. Rev. W. Miller Quarry. This quarry is situated 2 miles northeast of Elkton. The stone is white in color and oolitic.

5. Snugg Quarry. This quarry is on the Elkton-Russellville pike, 5 miles east of Elkton. This quarry is in the white, oolitic limestone.

Trigg County.

The limestones of Trigg County are white, grayish white, gray, and bluish gray in color. They are in part oolitic, medium to coarse grained, thick bedded, and can furnish good road building stone.

1. Cerulean Stone Company Quarry. This quarry is situated 1½ miles north of Cerulean. It is 650 feet in length, 600 feet in breadth, and the height of the working face is 53 feet. At the top of the quarry there is 10 feet of very hard, dark gray,

massive limestone that breaks with a conchoidal fracture. At the bottom of the quarry there is 15 feet of massive, dark gray limestone that is not flinty in character. This quarry operates a gyrating Gates crusher with 400-ton capacity. It is an excellent road stone.

2. Charles McQuerry Quarry. This quarry is situated one-half mile west of Cerulean, and the product is used for road construction.

3. This quarry is situated 1 mile south of Cerulean. The stone here is broken into dimension stone by hand only.

4. Cadiz Quarry. A quarry exists ½ mile north of Cadiz. The stone is used for foundation work and curbing at Cadiz.

Warren County.

The road building stones of Warren County are mostly quarried from the beds of the Gasper oolitic limestone. The beds vary in thickness from 10 to 22 feet, without seam or flaw. In color, the rock is "Royal White," white, very light gray, gray, and dark gray. All varieties weather white, or nearly white. The stone is oolitic and fine to medium grained. The fracture sometimes crosses the oolites, and sometimes it goes around them, so that the oolites stand out conspicuously on the broken surface. In polished samples the contrast is strong between the pure white exterior of the oolite and the darker interior. Most of the oolites are round, but some of them are elongated. The stone has perfect rift and grain, and lends itself to the most delicate carving. When freshly quarried, it is somewhat stained by bituminous stubstances, which completely evaporate upon exposure to the atmosphere. The seasoned stone, therefore, is white, or nearly white.

1. Green River Quarry. This quarry is situated about 6 miles northwest of Bowling Green. Some of the beds are 20 feet in thickness without seam or flaw. The length of the quarry is 500 feet. The breadth is approximately 500 feet. The stone has been quarried over the entire area now covered by waste material. A spur of the railroad carries the stone from the quarry to Barren River. It is then transported by barges to Bowling Green for manufacture.

2. White Stone Quarry. This quarry is situated approximately 5 miles southwest of Bowling Green. The length of the quarry is 800 feet and the breadth is 500 feet. The thickness of the individual beds is 20 feet. Modern quarrying machinery is here installed, and the quarry products are shipped by a spur

3. THIRTEENTH STREET, BOWLING GREEN, KY.
This street was finished July 25, 1922, and photographed August 16, 1923.

of the Louisville & Nashville Railroad to the main line, and then to Bowling Green for manufacture.

3. Knob Church Quarry. This quarry is situated about 7 miles southwest of the city of Bowling Green, and in close proximity to the Knob Church. The length of the quarry is about 500 feet. The breadth of the quarry is about 150 feet. The quarry does not appear to have been worked to a depth exceeding 8 or 10 feet. There is but little overburden to be removed. Channeling machines do not appear to have been used, but explosives were used. The outline of the working face is markedly irregular, showing that little attention was paid to the rift of the stone.

A part of the limestone at this quarry is light gray in color and banded. The alternating layers of different hues are very narrow. The stone is oolitic and fine to medium grained. The stone quarried here was removed by a spur of the Louisville &

Nashville Railroad. This site furnishes a good opportunity for reopening the quarry for road stone.

4. Bowling Green Whitehouse Quarry of Kentucky. This quarry is situated at Memphis Junction on the Louisville & Nashville Railroad. The stone is here thick bedded, white, oolitic, and

34. COLLEGE STREET, BOWLING GREEN, KY.
This cut shows a graveled macadam road that has been treated with heavy oil.

fine for road building purposes. The product is used by the Louisville & Nashville Railroad.

5. Kissler and Rigelwood Quarry. This quarry is situated about 4½ miles southwest of Bowling Green, and about one-half mile northeast of the White Stone quarry. The quarry is in the thick bedded, white, oolitic limestone. The product is controlled by the Louisville & Nashville Railroad. The limestone here dips 2 degrees to the west.

6. County Quarry. This quarry is on the Nashville pike, about 1½ miles south of Bowling Green. There is a crusher at this quarry with a capacity of 100 tons. The quarry is in the Ste. Genevieve limestone, and the product is used for road construction.

7. Jordan & Sons Quarry. This quarry is situated on the

Russellville pike, about 3 miles southwest of Bowling Green. The quarry is in the Ste. Genevieve limestone.

8. Rockfield Quarry. This quarry is about 8 miles southwest of Bowling Green, and about one-half mile west of the Russellville pike.

9. Stewarts Quarry. This quarry is situated 9 miles southwest of Bowling Green, and about one-half mile west of the Russellville pike. The stone is shipped by a spur to the Memphis Branch of the Louisville & Nashville Railroad.

10. Smallhouse Quarry. This quarry is situated in the Knob Church area, about 7 miles southwest of Bowling Green.

11. City Quarry. This quarry is situated just outside the city limits, directly north of the city. This quarry is in the Ste. Genevieve limestone.

12. Underwood Quarry. This quarry is located on both sides of the Richardsville pike, about 3 miles north of Bowling Green. The quarry is now inactive.

13. Moultenburg Quarry. This quarry is on the Morgantown pike, 2½ miles west of Bowling Green, with the actual quarry about 80 rods to the left of the pike.

14, 15. Victoria Limestone Company Quarries. These quarries are situated near Slim Island, about 5 miles northwest of Bowling Green on the north side of Barren River. The stone was shipped to the river by rail. These quarries are now inactive.

16, 17, 18. N. P. Thomas Quarries. These quarries are situated 7 miles northwest of Bowling Green on the farm of N. P. Thomas, now leased by J. E. Condra, and Mrs. A. G. W. Killow. The stone is of very good quality.

19. Caden Stone Company Quarry. This quarry is situated on Gasper River, and about 9 miles northwest of Bowling Green. The beds at this quarry dip 1½ degrees to the northwest. The quarry has been in successful operation for over 50 years, and the product largely shipped to Evansville, Indiana, for manufacture.

20. Green Castle Quarry. This quarry is on Barren River at the mouth of Lost Creek, 8 miles northwest of Bowling Green. The stone is shipped to Bowling Green by barges.

21. This quarry is 12 miles northwest of Bowling Green on the head of Clay Lick Creek. It is on the west side of the Bowling Green and Woodbury road. The stone is used in the construction of the pike. It is a coarse grained limestone that would make a good road building stone.

22. This quarry is situated in the extreme northern part of Warren County, 1½ miles east of Woodbury, Butler County. The quarry is on the west bank of Clay Lick Creek, in a yellowish brown sandstone of the Bee Springs formation of the Pennsylvanian system. The quarry opening is 100 feet in length, 50 feet in breadth, with height of working face 40 feet. The individual beds are from 6 to 18 inches in thickness, and slightly banded with iron stains.

23. City Quarry No. 2. This is a new quarry opened a few rods to the right of No. 11. The product is used in street and road work. The stone is good.

No. of County	Name of County	No. of Quarries in County
76	Adair	3
77	Allen	2
78	Barren	9
79	Breckinridge	5
80	Caldwell	6
81	Casey	0
82	Christian	12
83	Crittenden	10
84	Cumberland	1
85	Edmonson	1
86	Grayson	12
87	Green	1
88	Hardin	6
89	Hart	6
90	Larue	3
91	Livingston	3
92	Logan	16
93	Lyon	8
94	Meade	3
95	Metcalfe	1
96	Monroe	1
97	Russell	1
98	Simpson	2

No. of County	Name of County	No. of Quarries in County
99	Taylor	1
100	Todd	5
101	Trigg	4
102	Warren	23
	Total number of quarries	145

CHAPTER VIII.

THE WESTERN COAL FIELD.

The western coal field embraces a smaller number of counties than any other geographic province of the State, with the single exception of the Jackson Purchase. The area is situated in the western part of Kentucky and lies between the Ohio River on the north and the Mississippian terranes on the south. Grayson and Edmonson counties were included in the preceding chapter, for they are not strictly considered western coal measure counties. Their terranes, however, are about equally divided between the limestones and the sandstones. The terranes described in this chapter are predominantly Pennsylvanian, and but few quarries supplying good road building materials can be cited.

Butler County.

There is an abundance of good sandstone in Butler County some of which is suitable for base course work in road construction.

The limestones are prominent in the southern and southwestern portions of the county. Some of these are suitable for road construction, especially in the southwestern portion of the county. A good quarry in limestone of Mississippian age is located 3 miles southwest of Woodbury post office on the road to Sugar Grove. This limestone has been used in road construction with exceelent results. A quarry in the lower Pottsville sandstone three and one-half miles south of Morgantown on the Bowling Green road has also been extensively used for building construction, principally foundations.

Daviess County.

The terranes of Daviess County are all sandstones. There are no known quarries within the county. Perhaps a reason for this lies in the fact that Daviess County has an ample supply of good river gravel for the construction of roads. This is

dredged from the Ohio River at Owensboro, and used in road work and concrete both on highways and city streets.

Bank gravel occurs in a somewhat limited deposit on Iron Ore Hill. It has given good results wherever used.

Hancock County.

The terranes of Hancock County are prevailingly sandstone. The only quarry known in the county is in sandstone, near Hawesville. The stone has been used for curbing.

Gravel deposits exist in this county in adequate quantity to build all the roads within the county.

1. Skillman gravel has been used by the Henderson and Louisville Railroad with good satisfaction. This deposit is located at Skillman.

2. This deposit is on the Louisville, Henderson and St. Louis Railroad, one mile east of Skillman on the farm of A. B. Sterrett. It is operated by the Hancock County Chert Gravel Co., of Hawesville, Ky. Analyses of this gravel are on file in the State Department of Roads and Highways where they may be reviewed.

3. This deposit is situated 2 miles west of Indian Lake and 1½ miles south of Indian Lake on the farm of Martin Minnett.

4. This deposit is 1¾ miles east of Hawesville and ½ mile south of Hawesville on the farm of T. D. Hale.

The above gravels are all good for road construction work. The size of the gravel is medium and well graded. It is finer in some cases than the Ohio River gravel, and generally coarser than the Purchase gravels in the western part of the Purchase. The cementing materials are clayey matter and the oxides of iron. Wherever used, these gravels appear to have given good satisfaction.

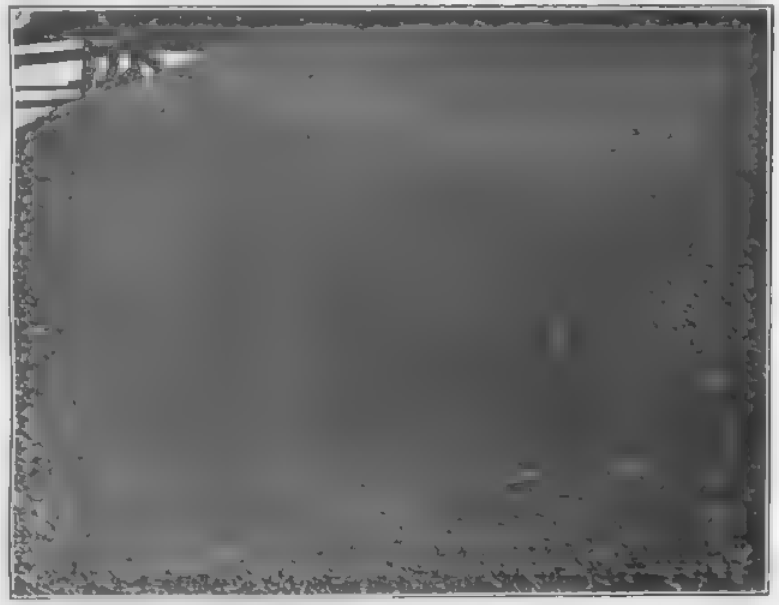
This gravel deposit is situated 2 miles west of Hawesville around Lead Creek. It is regarded as deficient in binding power.

Henderson County.

The terranes of Henderson County are sandstones. The one quarry in the county is at Smith's Mill. The stone was crushed and used in macadamizing roads.

Good gravel in Henderson County is fairly abundant. Where used, it seems to have given excellent satisfaction.

1. The Henderson Sand and Gravel Company pumps river gravel from the Ohio River 3 miles above Henderson. This Gravel is admixed with sand and requires screening. The ratio



37. SCREENED GRAVEL

This gravel was obtained from the Ohio River by the Henderson Sand and Gravel Company, Henderson, Henderson County, Ky.

of the gravel to the sand is approximately 1 to 4. The silica sand is medium in size, sharp, and clean. The gravel consists of sandstone, jasper, and chert pebbles, with a few pebbles of basic igneous rocks that are not native to Kentucky. These gravel beds extend up the Ohio River for at least 18 miles.

2. A gravel deposit exists on the farm of E. W. Reid of Hubbardsville. It is ½ mile south of the Henderson-Owensboro pike and 1½ miles west of Hamiltons Ferry. The gravel is fine to medium in size. The cementing materials are clayey matter and the hydrous oxides of iron. These are very abundant. The sample collected was from near the surface. It passed the

State requirements. This deposit is known to be 7 feet in thickness by pit holes sunk in it. Apparently, it is from 15 to 20 feet in thickness. This gravel appears also on two adjacent farms.

37. A CONCRETE MIXER AT WORK.
This machine is mixing concrete for paving the streets of Henderson, Henderson County, Ky.

Hopkins County.

The terranes of Hopkins County comprise both limestones and sandstones. Five of the eight quarries within the county are in the sandstone series.

1. Major M. K. Gordon Quarry. This quarry is situated just east of the little lake on Ebenezer Street, six blocks west of the courthouse at Madisonville. The quarry is in a bluish gray limestone and the product used for foundation work, bridges, culverts and curbing.

2. Browning Springs Quarry. This quarry is situated at the west end of Arch Street, five blocks west of the courthouse. This quarry is in the bluish gray limestone.

3. Sunlight Coal Company Quarry. This quarry is situated in the grapevine country three miles southeast of Madisonville. The quarry is in the bluish gray limestone.

4. Drakes Creek Quarry. This quarry is situated 2½ miles southeast of Nortonville on the Louisville & Nashville Railroad. The quarry is in a bluish gray sandstone.

5. Oak Hill Quarry. This quarry is one mile north of Nortonville on the Louisville & Nashville Railroad. The quarry is in sandstone. The individual beds are fifteen feet in thickness. The stone has been used for foundation work, abutments, bridges, culverts, curbing, etc.

6. Marion Page Quarry. This quarry is situated 2 miles south of Nortonville on the Louisville & Nashville Railroad. The quarry is operated by the Rodgers Brothers. It is in sandstone.

7. Grampian Hills Quarry. Some old abandoned sandstone quarries were found in the Grampian Hills near Madisonville. These quarries were opened nearly 100 years ago, and the stone used locally.

8. Dawson Springs Quarry. This quarry is about ½ mile south of Dawson Springs and is inactive.

McLean County.

The terranes of McLean County are all sandstones. They are all too soft for good road work. There is but one quarry in the county, and that is near Calhoun.

Gravel deposit are quite extensively developed within the county. Within a radius of approximately 5 miles of Calhoun the outcrops are essentially gravel. The approximate thickness of these gravels is 15 feet. They are as clean as dredged river gravel, and the supply is ample for all work desired.

Muhlenberg County.

The terranes for Muhlenberg County comprise both limestones and sandstones. Most of the sandstones are too friable for road work.

1. Mack Ferguson Quarry. This quarry is situated ½ mile west of South Carrollton. The quarry is in limestone. The

stone was quarried for road construction and burned into lime for both building and agricultural purposes.

2. Mack Ferguson Quarry. This quarry is situated ½ mile north of South Carrollton. In this quarry there is a buff sandstone on the top varying from 6 to 10 feet in thickness. The middle layer consists of a gray sandstone 4 feet in thickness. The bottom of the quarry contains 20 feet of fine grained, even textured blue sandstone.

When this quarry was active the stone was used by the Illinois Central and the Louisville & Nashville Railroads in piers and abutments for bridges. It was shipped to Georgia and Alabama. More than 500 carloads of stone were shipped from South Carrollton.

3. Mack Ferguson Quarry. This quarry is near the large quarry described as No. 2. It contains the same varieties of sandstone as No. 2, but has never been as extensively worked.

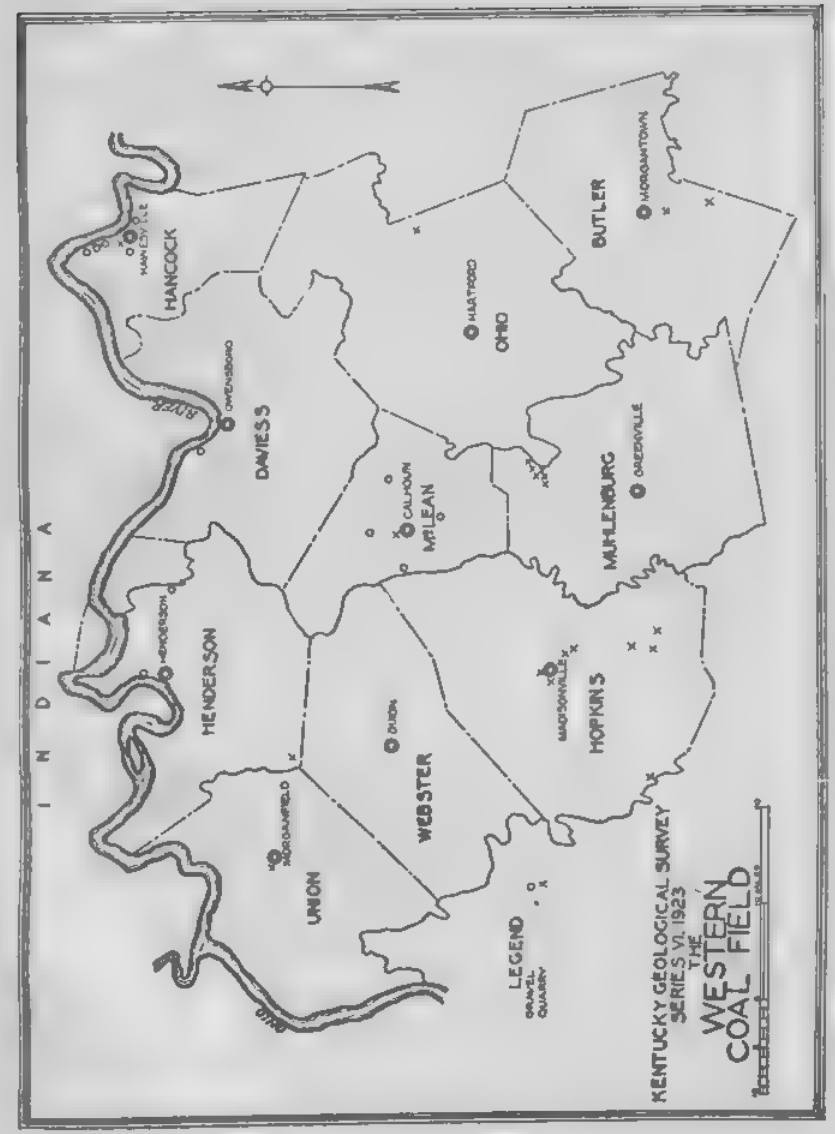
4. Mack Ferguson Quarry. This quarry is situated within the corporation limits on the east side of the town. The thick bedded sandstone here is very durable.

5. Ernest Purdy Quarry. This quarry is situated on the east bank of Green River. This quarry has been inactive for several years.

6. J. F. Wolcott Quarry. This quarry is near the bank of Green River just outside the city limits.

Ohio County.

The terranes of Ohio County fall both within the limestone and the sandstone series. The limestones northeast of Hartford should furnish road building stone. While most of the sandstones in Ohio County are soft, it is not regarded as impossible that fine grained, compact, bluish gray sandstones should be found that would meet State requirements for base course. An old abandoned quarry of small extent is located on the railroad at Narrows, Ky. It is in the upper Mississippian limestone. This quarry was not sampled. Large deposits of gravel also are found along the Green River at Smallhouse.



No. 38. Outline Road Materials Map of Western Coal Field.

Union County.

The terranes of Union County are sandstones. A little sandstone has been quarried near Morganfield. These are massive, thick bedded sandstones along the Tradewater River in the southern part of the county, but these sandstones are not used in road construction.

Webster County.

The possibilities of road building stone in Webster County lie in both the limestone and the sandstone series. There are numerous outcrops of limestone near Providence that should furnish road building material. Thick bedded, massive sandstones occur along the Tradewater River in the southwestern portion of the county. An old abandoned quarry in the lower Pottsville sandstone is located at Sebree. No active quarries were found in either the limestone or the sandstone series.

No. of County	Name of County	No. of Quarries in County
103	Butler	2
104	Daviess	0
105	Hancock	1
106	Henderson	1
107	Hopkins	8
108	McLean	1
109	Muhlenberg	6
110.	Ohio	1
111	Union	1
112	Webster	1
	Total number of quarries	22

CHAPTER IX.

THE JACKSON PURCHASE.

The Jackson Purchase embraces a smaller number of counties than any other geographic province of the State. It is situated in the extreme southwestern corner of Kentucky. Three of its boundary lines are navigable rivers. It is bounded on the north by the Ohio River, on the east by the Tennessee River, on the south by the State of Tennessee, on the west by the Mississippi River. Its terranes are represented by the youngest rocks of the State. Nearly all of them belong to the Cretaceous and Quaternary systems. They are largely unconsolidated sediments. When consolidation has taken place in these younger geologic formations, the cementing material is clayey matter, and the oxides and hydrous oxides of iron. Wherever the Mississippian limestone outcrops in Calloway and Marshall counties in the eastern part of the Jackson Purchase, the altitudes are low, the region swampy, and the limestones thin bedded. From these limestones little, if any, good road building metal may be expected.

The Purchase, however, contains large deposits of high grade gravel. These are not confined to the rivers and creeks, for bank gravel is especially abundant over a large portion of this province. These gravels are practically inexhaustible in supply. The tonnage appears large enough to gravel surface every highway in the State of Kentucky.

The gravels of the Purchase naturally divide themselves into three classes:

(1) River gravels, commonly known as Paducah gravels.

(2) Bank gravels.

(3) Creek gravels. The creek gravels may be classified as a subdivision of the bank gravels. They are modified bank gravels that have lost some of their cementing or bonding material. The author suggests that the term Paducah gravel be restricted to the river gravels obtained from the Ohio and Tennessee Rivers, and the term Purchase gravel used for all the

bank and creek gravels. All these gravels have been used in the manufacture of concrete for constructional purposes and for permanent roads.

Paducah Gravels: The Paducah gravels are mostly water worn and well rounded sandstone, jasper, flint, and chert pebbles with few, if any, limestone pebbles. It is practically free from coal. The sand associated with it is a silica sand containing a little iron oxide as a stain upon the sand grains. It contains no clayey matter.

The Ohio River Sand and Gravel Company of Paducah obtains its gravel from near the mouth of the Tennessee River about 4 miles above Paducah.

Bank Gravels: The widely distributed bank gravels consist essentially of jasper and chert pebbles that are well waterworn and well rounded. There are a few pebbles of vein quartz, but no coal. They average much smaller in dimensions than the Paducah gravels. They are often found in stratified positions, suggesting a fluviatile origin. They probably represent siliceous residues from Mississippian terranes.

The gravels in the eastern part of the Purchase are coarser than those in the central and western parts. They are, also, richer in their iron oxide content and more reddish brown in color. This iron content makes a very satisfactory bonding material. The lighter colored and finer gravels toward the western part of the Purchase are the richer in their content of clayey matter.

Ballard County.

There are no quarries in Ballard County. Gravel for concrete work has been obtained from the Ohio River. The Purchase gravels of the Lafayette formation extend over the entire upland area, except where the sand and gravel have been removed by stream erosion. This formation varies from 10 to 30 feet in thickness.

The gravel in the terranes in the northern part of the county appears somewhat coarser than the average Lafayette gravels, and contains more sandstone pebbles. This implies that these

gravels belong to the Paducah gravels. If so, they are of later age than the Lafayette gravels.

The gravel deposits that are considered very good for road work a few miles east of Wickliffe extend in a broken line in a northwesterly direction into Illinois. The gravel near Wickliffe is a little finer and contains less clayey matter than that of Tamms, Illinois.

Calloway County.

There are no quarries in Calloway County. There are, however, outcrops of Mississippian limestone on the road from New Concord to Patterson's Store on the Tennessee River, and about 2 miles west of the store, that are worthy of careful investigation as a possible source of road building material within the eastern part of the Purchase. The outcrop is narrow and the thickness not great.

The bank gravels, Lafayette, are especially abundant in the central and eastern part of the county. The beds vary from 20 to 40 feet in thickness. An excellent exposure occurs in the railway gravel pit just south of Murray. In this pit there is 25 feet of gravel with an 8-foot overburden of sandy clay. This gravel is highly ferruginous and prevailingly orange colored. It is cross-bedded, contains some sand pockets and some limonite crusts. The iron oxides serve as a binder, so that this gravel will make a very satisfactory road metal.

Carlisle County.

There are no quarries in Carlisle County, but several most excellent gravel pits. These Purchase gravels, Lafayette sand and gravel, vary from 10 to 35 feet in thickness and are widely distributed.

1. Excellent gravel, rich in its iron content, occurs a little northeast of Columbus.

2. The California Hills between Milburn and Cunningham are practically all gravel. This gravel is of medium size, in part reddish brown and in part whitish in color. Both iron oxides and clayey matter serve as the cementing materials.

3. There is an excellent gravel pit just outside the corporate limits of Milburn on land owned by George R. Brent. This pit has been worked to a depth of 26 feet, and is known to be at least 5 feet deeper. The overburden is very light, varying from 2 to 4 feet. The cementing materials are clayey matter and

39. GRAVEL PIT, MILBURN, CARLISLE COUNTY, KY.
The cut shows a very light overburden and the bonding power of the gravel.

iron oxides. That the cement is present in sufficient quantity for road work is proven by the fact that the pit maintains vertical slopes and, in fact, may be undercut. The pit walls carry one short lens of sand from 2 to 6 inches in thickness. No clay seams were observed. This gravel is reported as one of the best within the Purchase, and the supply is practically unlimited.

4. A reddish brown gravel occurs on the farm of William Morefield, also just outside the corporate limits of Milburn. The gravel on the I. Peebles farm is practically the same as that of George R. Brent. These gravels have been used in the construction of several miles of gravel roads around Milburn.

Fulton County.

There are no quarries in Fulton County. All the gravel and crushed stone used in construction work has been shipped in from other localities. The Lafayette sand and gravel formation appears in the northwestern part of the county, but the gravels when present are fine in texture and rich in clayey matter. The excess of this binder is injurious to the gravel. It is not regarded by the author that the Purchase gravels occur in commercial deposits in Fulton County.

Graves County.

There are no quarries in Graves County. There are, however, a number of gravel pits that have furnished excellent gravel for road construction.

The Purchase gravels reach their most extensive development in Graves County. The upper portion of the Lafayette formation contains an appreciable amount of orange colored sand. The lower portion is, as a rule, a highly ferruginous gravel that makes a most excellent road surfacing material.

40. GRAVEL BED NEAR MAYFIELD, KY.
This gravel deposit is situated ½ mile south of Mayfield, Graves County, Ky. The head of the hammer is at the contact of the overburden and the gravel.

The gravel road from Mayfield extends in southerly direction toward the Tennessee line 13 miles. The section between Mayfield and Sedalia is very satisfactory, while that section between Sedalia and the east-west road to Lynnville is ribbed, often narrow, and in places poorly drained.

41. GRAVEL ROAD, MAYFIELD, KY.
This gravel road extends south from Mayfield, Graves County, Ky., to Sedalia.

42. A CLAY ROAD.
This cut shows the ruts produced by tracking in the same place. The road is in the Jackson Purchase between Mayfield and Fulton.

1. The town gravel pit is situated just east of the railroad track in the southern part of Mayfield. The Lafayette gravel represents the lower portion, and the Columbia loam the upper

portion. There is some sand in the gravel, some limonite crusts, and sufficient clayey matter to enable the pit to withstand vertical faces. The Purchase gravel bed is here 22 feet thick.

2. This gravel pit is ½ mile south of Mayfield on the Peyossburg road. The gravel varies from 10 to 15 feet in thickness, and the overburden from 1 to 5 feet.

3. Gravel pits were also found between Sedalia and Lynnville, also just outside of Wingo and near Water Valley. According to D. H. Davis, Assistant Geologist of the Kentucky Survey, Lafayette gravels can be obtained in almost any part of Graves County in commercial quantity.

The following changes were observed in the Purchase gravels in traversing a line from Mayfield, Graves County, to Fulton, Fulton County:

1) Increase in thickness of overburden.
2) Decrease in the size of the gravel
3) Increase in the whiteness of the gravel
4) Increase in the sand and clay content
5) Decrease in the amount of iron oxides
6) Commercial gravel disappears near the Graves-Fulton County line.

Hickman County.

There was once a sandstone quarry in operation in Hickman County, but the quarry was exhausted many years ago. The Purchase gravels in the Columbus bluff reach a thickness of 20 feet. This is overlaid by sand, also of the Lafayette formation about 15 feet in thickness. This gravel is rich in iron and considered good. The gravels around Cypress and to the south of Cypress are regarded as fair.

McCracken County.

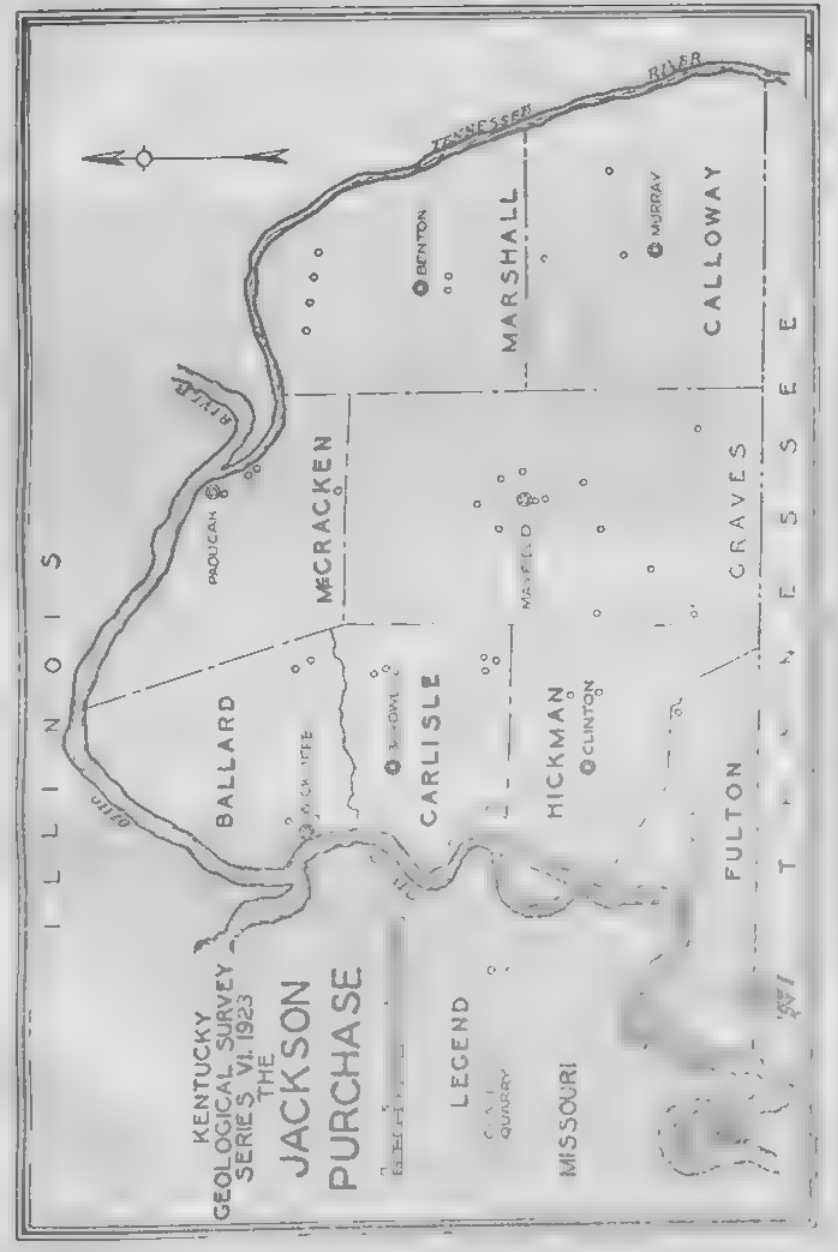
There are no quarries in McCracken County. There is, however, an abundance of both river gravel and bank gravel in the county.

1. The river gravel, is commonly known as Paducah gravel. The Ohio River Sand and Gravel Company, as else

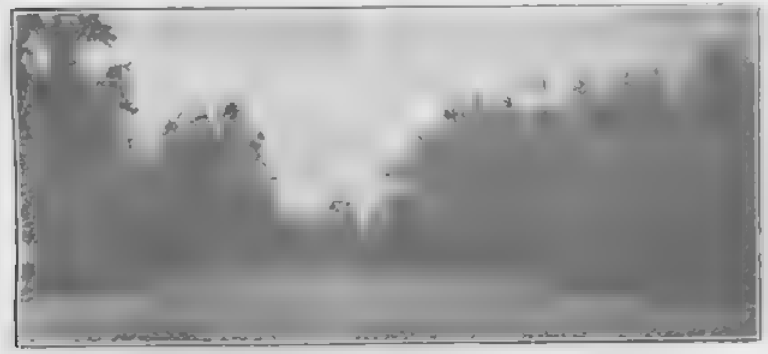
where noted in this chapter, operates an extensive plant for marketing this product.

43. TIEBOLDS SAND AND GRAVEL PIT.
[illegible] McCracken County, Ky. The cut shows the [illegible] loading the gravel at Paducah.

44. LOADING GRAVEL FOR SHIPMENT.
A car of Paducah gravel being emptied into a freight car at the plant of the Ohio River Sand and Gravel Company, Paducah, McCracken County, Ky.



2. The Terrells sand and gravel pit is situated within the corporate limits of the city of Paducah and on the north side of the city. This gravel has been used for several years with excellent satisfaction in surfacing the streets of Paducah.



FOUNTAIN AVE., PADUCAH, McCRACKEN COUNTY, KY.
This gravel road was constructed about [illegible] and little, if any,

Marshall County.

There are no known quarries in Marshall County. The Mammoth Cave limestone series may possibly contain beds of limestone that can be used for road construction. This belt of limestone is in the eastern part of the county, and varies in width from 4 to 6 miles.

The Purchase gravels, Lafayette formation, are well represented in Marshall County. A wide belt of this gravel extends in a somewhat northwesterly direction from Agnes Ferry on the Tennessee River to the village of Sharp.

The best gravel beds in this county are situated a little south of Benton. The gravels vary from 15 to 30 feet in thickness. The thicker beds, as a rule, are in the eastern part of the county. In many places the gravels are cemented into a ferruginous conglomerate which, when broken up, should make a most excellent road material.

From the wide distribution of the Purchase gravels, and a careful field study of their relative depths, the author is convinced that these gravels exist in sufficient amount to construct

entirely of gravel every road within the Jackson Purchase, and that the supply is practically unlimited.

No. of County	Name of County	No. of Quarries in County
113	Ballard	0
114	Calloway	0
115	Carlisle	0
116	Fulton	0
117	Graves	0
118	Hickman	0
119	McCracken	0
120	Marshall	0
	Total number of quarries..	0
	Total number of quarries for State.	750

GRAVELED ROAD NEAR PADUCAH, McCRACKEN COUNTY, KY. (In cut shows the value of the Purchase gravels in the construction of permanent roads.)

CHAPTER X.

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Special Test on Sandstone

State Highway Testing Laboratory

University of Kentucky, Jan. 25th, 1923.

County	Lab. No.	Identification Mark	Submitted By	Specific Gravity	Wt. Per Cu. Ft.	Water Absorption	Per Cent of Wear	Hardness	Toughness	Crushing Strength
Letcher	7652	No. 1 East	Paul Owens	2.44	152.5	138.	7.0			5870
Letcher	7584-B	A	T. J. Eppes	2.66	162.2	127.	2.9			5960
Letcher	7585-B	B	T. J. Eppes	2.73	171.8	198.2	3.0			
Letcher	7584-A	A	T. J. Eppes	2.51	156.8	155.4	6.6			5380
Letcher	7585-A	B	T. J. Eppes	2.25	140.6	149.	6.8			
Knox	7653	W. M. Mitchell	W. T. Rye	2.72	170.	125.	7.4			3660
Knox	7626	1	J. R. Drummy	2.34	146.6	310.	9.62	Too soft	6.0	4110
Knox	7627	2	J. R. Drummy	2.62	163.7	235.	18.0	10.9	4.0	4050
Knox	7628	3	J. R. Drummy	2.30	143.7	320.	6.0	11.5	7.0	4630
Knox	7629	4	J. R. Drummy	2.57	160.6	335.	8.66	0.3	5.0	5350
Knox	7630	5	J. R. Drummy	2.41	150.6	301.	8.89	13.8	6.0	3900
Magoffin	7623	Sta. No. 115	J. R. Cloyd	2.81	175.6	214.	2.5			4310
Magoffin	7624	Sta. No. 00	J. R. Cloyd	2.45	153.1	251.	7.8			4090
Magoffin	7625	Sta. No. 135	J. R. Cloyd	2.40	150.0	287.	10.0			3900
Harlan	7645	No. 4	J. B. Walker	2.47	154.	47.4	4.8			3340
Harlan	7644	No. 3	J. B. Walker	2.38	148.7	200.	5.6	3.9	5.0	4830
Harlan	7643	No. 2	J. B. Walker	2.78	170.	310.	7.0	17.5	8.0	4360
Harlan	7642	No. 1	J. B. Walker	2.65	165.6	237.	3.0			5480
Rowan	7646	No. 1	J. S. Ingram	2.39	149.3	31.14	5.8	Too soft	10.0	4620
Rowan	7647	No. 2	J. S. Ingram	2.39	149.3	29.1	5.7	1.4	10.0	4990
Rowan	7648	No. 3	J. S. Ingram	2.67	166.8	64.2	2.9			5120
Rowan	7649	No. 4	J. S. Ingram	2.33	146.6	23.7	5.3	2.5	5.0	7180
Rowan	7650	No. 5	J. S. Ingram	2.41	150.6	35.6	5.6	Too soft	11.5	6200
Johnson	7606	No. 1	A. W. Brown	2.51	156.8	22.6	18.0			
Carter	7655	Isam Eden	J. M. Scarcer	2.28	142.5	88.1	6.9			5180
Carter	7654	Ike Stamper	J. M. Scarcer	2.67	166.8	35.1	4.9			3250

Lawrence	7586	No. 1	C. R. Sarsburg	2.26	141.2	22.1	15.5	Too soft	6.0	4990
Lawrence	7587	No. 2	C. R. Sarsburg	2.38	148.7	15.3	24.0	Too soft	4.0	5090
Lawrence	7588	No. 3	C. R. Sarsburg	2.37	148.1	15.6	36.9	Too soft	3.0	3850
Lawrence	7589	No. 4	C. R. Sarsburg	2.48	150.0	31.8	23.5	Too soft	5.0	3130
Lawrence	7590	No. 5	C. R. Sarsburg	2.46	153.7	26.0	7.2			3650
Lawrence	7597	No. 6	C. R. Sarsburg	2.29	143.1	35.6	45.0	Too soft	4.0	5930
Lawrence	7598	No. 7	C. R. Sarsburg	2.39	149.3	19.0	38.0	Too soft	3.5	2570
Lawrence	7599	No. 8	C. R. Sarsburg	2.31	144.3	15.4	39.0	Too soft	4.5	3470
Lawrence	7601	No. 9	C. R. Sarsburg	2.31	144.3	23.0	19.2	Too soft		
Lawrence	7602	No. 10	C. R. Sarsburg	2.68	167.4	39.0	11.0	Too soft	6.5	3860
Lawrence	7603	No. 11	C. R. Sarsburg	2.44	152.5	21.0	13.5	Too soft	7.0	2950
Lawrence	7604	No. 12	C. R. Sarsburg	2.37	148.1	20.6	28.0	Too soft	3.5	3470
Lawrence	7605	No. 13	C. R. Sarsburg	2.50	156.2	23.0	8.8	Too soft	8.0	4590
Lawrence	7606	No. 14	C. R. Sarsburg	2.24	141.8	16.6	26.0	Too soft	6.0	
Pike	7578	Tom Blackbutte	S. J. Hardin	2.56	160	38.0	5.6	5.5	5.5	
Pike	7579	Pauleg Heirs	S. J. Hardin	2.58	162.5	49.6	7.0			5950
Leslie	7595	No. 4	J. A. Thomas	2.86	178.7	50.2	4.0			4640
Leslie	7594	No. 3	J. A. Thomas	2.59	161.8	25.4	6.0	Too soft	7.0	3870
Leslie	7593	No. 2	J. A. Thomas	2.47	154.3	32.3	6.8	Too soft	6.5	
Leslie	7596	No. 5	J. A. Thomas	2.52	157.5	42.0	7.4			3750
Perry	7577	Sta. 49	J. M. Davidson	2.48	155.0	47	7.5			
Whitley	7631	No. 1	M. J. Warren	2.62	163.7	42.6	7.5	15.5	6.0	3390
Whitley	7632	No. 2	M. J. Warren	2.65	165.0	55.3	9.6	17.6	12.0	6870
Whitley	7633	No. 3	M. J. Warren	2.54	158.7	28.6	5.4	3.1	8.0	6980
Whitley	7634	No. 3-1	M. J. Warren	2.51	156.8	25.5	8.0	Too soft	6.0	3070
Whitley	7635	No. 4	M. J. Warren	2.49	155.6	32.6	4.0	3.0	10.0	5740
Whitley	7636	No. 5	M. J. Warren	2.50	156.0	37.2	4.6	9.5	12.0	5200
Whitley	7637	No. 6	M. J. Warren	2.53	158.0	24.0	10.2			3470
Whitley	7638	No. 7	M. J. Warren	2.52	157.5	26.9	6.0	Too soft	6.0	4800
Whitley	7639	No. 8	M. J. Warren	2.44	152.5	31.5	6.3	Too soft	8.0	7560
Whitley	7640	No. 9	M. J. Warren	2.51	157.8	47.4	4.6	17.7	9.0	7130
Whitley	7641	No. 10	M. J. Warren	2.44	152.5	26.0	7.6	Too soft	6.0	5300
Lee	7679	Sta. 580	H. K. McCormick	2.47	154.0	53.0	9.4	5.5	11.0	4950
Laurel	7678	400' left, Sta. 102	McClain Mitchell	2.31	144.0	35.0	57.3			3920
Laurel	7677	500' left, Sta. 107	McClain Mitchell	2.54	159.0	24.8	78.0			

Special Tests on Rocks Essentially Limestone
State Highway Testing Laboratory
University of Kentucky, Jan. 25th, 1923.

County	Kind of Stone	Name of Quarry or Location	Specific Gravity	Wt. Per Cu. Ft.	Water Absorption	Per Ct. of Wear	Remarks
Anderson	Limestone	Tyrone	2.68	167.5	1 in 299	3.9	Meets specifications all classes.
Barren	Limestone	Sta. 92, F. A. 28	2.5	156.2	.....	5.8	Meets specifications all classes.
Barren	Limestone	Sta. 289, F. A. 28-B	2.7	168.7	.....	4.3	Meets specifications all classes.
Barren	Limestone	Frank Richardson	.....	.....	1—341	3.5	Meets specifications all classes.
Bell	Sandstone	Asher Leese	2.52	157.5	1— 63.1	3.4	Meets specifications all classes.
Bell	Sandstone	Varilla Coal Co.	2.40	150.0	1— 69.6	3.1	Meets specifications all classes.
Bourbon	Limestone	Bourbon Co.	2.70	168.7	1—147	5.6	Meets specifications all classes.
Boyle	Limestone	Winfield Crain	2.71	169.3	1—175	5.6	Meets specifications all classes.
Boyle	Limestone	Carpenter	2.70	168.7	1—165	4.3	Meets specifications all classes.
Boyle	Limestone	Davis	2.75	171.8	1—275	4.0	Meets specifications all classes.
Breckinridge	Limestone	Beard Bros.	2.48	155	1— 53	5.3	Meets specifications all classes.
Bullitt	Limestone	Jess Calvert	2.6	162.5	1— 66.2	6.36	Meets specifications all classes.
Bullitt	Limestone	Mrs. Alice Collins	2.5	156.2	1— 43.1	5.46	Meets specifications all classes.
Carroll	Limestone	Sta. 413-417, St. A. 46	2.59	161.8	1—119.8	6.3	Meets specifications all classes except concrete surface
Carter	Limestone	Stamper	2.71	169.3	.....	3.8	Meets specifications all classes.
Carter	Limestone	Olive Hill	2.78	173.7	1—161	3.97	Meets specifications all classes.
Caldwell	Limestone	Katerjohn	2.54	158.7	1—126	3.2	Meets specifications all classes.
Christian	Limestone	I. W. Blakey	2.55	159.4	1—197	4.6	Meets specifications all classes.
Christian	Limestone	Cook Stone Co.	2.86	178.7	1—367	4.8	Meets specifications all classes.
Christian	Limestone	R. M. Fairleigh	2.78	173.7	1—475	3.7	Meets specifications all classes.
Clark	Limestone	Calmes	2.71	169.3	1—463	5.7	Meets specifications all classes.
Clark	Limestone	Mt. Zion	2.74	171.	1—289	5.8	Meets specifications all classes.
Clinton	Limestone	Sta. 23	2.69	168.	1—590	3.3	Meets specifications all classes.
Clinton	Limestone	Sta. 230	2.70	168.75	1—594	3.7	Meets specifications all classes.
Crittenden	Limestone	W. B. Harpending	2.64	165.	1—860	4.3	Meets specifications all classes.
Crittenden	Sandstone	J. H. Moore	2.44	152.5	1—310	5.9	Meets specifications all classes.
Crittenden	Limestone	C. C. Turner	2.71	169.3	1—380	5.1	Meets specifications all classes.
Edmonson	Limestone	B. N. Hawkins	2.63	164.3	1—284	3.7	Meets specifications all classes.
Edmonson	Limestone	Frank Butram	2.62	163.7	1—202	4.2	Meets specifications all classes.
Edmonson	Limestone	Robert Morris	2.62	163.7	1—185	4.2	Meets specifications all classes.

Estill	Limestone	Joe Barnes	2.68	167.	1—356	4.8	Meets specifications all classes.
Estill	Limestone	M. Tipton	2.7	168.7	1—302	5.6	Meets specifications all classes.
Estill	Limestone	H. G. Witt	2.58	161.2	.....	4.8	Meets specifications all classes.
Green	Limestone	Sta. 155, St. A. 41-A	2.75	171.8	1—155	4.0	Meets specifications all classes.
Green	Limestone	Sta. 38 to 40, St. A. 41-A	2.65	165.6	1—362	3.2	Meets specifications all classes.
Hardin	Limestone	John Masters	2.67	166.8	1—181	4.7	Meets specifications all classes.
Hardin	Limestone	Davis	2.60	162.5	1—119	4.9	Meets specifications all classes.
Hardin	Limestone	Marion Bailey	2.75	171.8	1—787	3.5	Meets specifications all classes.
Harlan	Sandstone	Sta. 11-50 St. A. 56	2.49	155.6	1—272	6.0	Meets specifications, base course, concrete, masonry.
Harlan	Sandstone	Sta. 189	2.59	161.8	1— 29	3.9	Meets specifications all classes.
Harlan	Sandstone	Lynch Mines	2.4	150.	.....	6.3	Meets specifications, base course, concrete, masonry.
Harrison	Limestone	Poindexter	2.66	166.2	1—275	4.8	Meets specifications all classes.
Hart	Limestone	J. R. Oaks	2.74	171.2	1—237	3.6	Meets specifications all classes.
Hart	Limestone	Sam Brumel	2.62	163.7	1—131	4.9	Meets specifications all classes.
Jessamine	Limestone	Wm. Reynolds	2.67	166.8	1—312	2.7	Meets specifications all classes.
Jessamine	Limestone	Sta. 194, F. A. 24	2.70	168.7	1—212	6.1	Meets specifications all classes except concrete surface
Jessamine	Limestone	Acie Jewel	2.58	161.25	1—231	6.1	Meets specifications all classes except concrete surface
Knox	Sandstone	Gilliam Hill	2.55	159.3	1— 54	4.8	Meets specifications, base course, concrete, masonry.
Knox	Sandstone	Sta. 135, St. A. 5	2.30	143.7	1— 32	6.0	Meets specifications, base course, concrete, masonry.
Larue	Limestone	Walter Lane	2.84	177.5	1—170	3.4	Meets specifications all classes.
Leslie	Sandstone	T. G. Lewis	2.59	161.8	1— 54.8	5.5	Meets specifications, base course, concrete, masonry.
Lee	Limestone	Sta. 459, St. A. 29-B	2.63	164.3	1—450	3.6	Meets specifications all classes.
Lee	Limestone	Flahven Land Co.	2.52	157.5	1—275	4.9	Meets specifications all classes.
Lee	Limestone	Sta. 144, Sta. A. 29-A	2.63	164.3	1—177	3.8	Meets specifications all classes.
Letcher	Limestone	½ mi. N. of Town Gap	2.71	169.3	.....	4.7	Meets specifications all classes.
Lewis	Limestone	Dyer	2.88	180.	1— 64	5.2	Meets specifications all classes.
Lewis	Limestone	Isaac Calvert	2.76	172.5	1—162	6.0	Meets specifications all classes.
Lewis	Limestone	Lucas	2.65	165.6	1—417	6.4	Meets specifications all classes except concrete surface
Lincoln	Limestone	Dave Burton	2.66	166.2	1—267	4.0	Meets specifications all classes.
Lincoln	Limestone	Clays	2.70	168.7	1—217	4.3	Meets specifications all classes.
Lincoln	Limestone	Barnett Farm	2.65	165.6	1—218	4.6	Meets specifications all classes.
Livingston	Limestone	I. S. Kirk	2.71	169.3	1—225	4.5	Meets specifications all classes.
Livingston	Sandstone	D. A. Dunn	2.5	156.2	1—192	1.9	Meets specifications, concrete, bit. macadam, hot mix.
Logan	Limestone	Geo. Covington	2.73	170.6	.....	3.0	Meets specifications all classes.
Madison	Limestone	Rogersville	2.78	173.7	1—408	4.8	Meets specifications all classes.
Madison	Limestone	Duncan and Wages	2.72	170.	1—395	5.4	Meets specifications all classes.
Madison	Limestone	W. A. Williams	2.56	160.	1—457	3.7	Meets specifications all classes.
McCreary	Limestone	Stearns Coal Co.	2.64	165.	1—444	4.0	Meets specifications all classes.
Meade	Limestone	Brandenburg	2.63	164.	1—563	4.2	Meets specifications all classes.
Mason	Limestone	Baytes-Paynter	2.50	156.2	1—150	6.0	Meets specifications all classes.
Menifee	Limestone	Harrison Little	2.7	168.7	1—436	3.2	Meets specifications all classes.
Montgomery	Limestone	Sid Hart	2.70	168.7	1—220	6.4	Meets specifications all classes except concrete surface
Muhlenberg	Sandstone	Sta. 141, St. A. 10-B	2.47	154.3	1— 20.5	14.0	Meets specifications for masonry.

APPENDIX 3—Continued.

County	Kind of Stone	Name of Quarry or Location	Specific Gravity	Wt. Per Cu. Ft.	Water Absorption	Per Ct. of Wear	Remarks
Morgan	Sandstone	Taylor Lewis	2.45	153.1	1— 38.7	6.0	Meets specifications for masonry.
Morgan	Sandstone	Kelley Nichols	2.3	143.5	1— 8.4	5.2	Meets specifications for masonry and concrete.
Nelson	Limestone	Phil Crume	2.7	168.7	1—390	5.1	Meets specifications all classes.
Pendleton	Limestone	Sta. 190-192, St. A. 21	2.66	166.25	1—296.5	5.7	Meets specifications all classes.
Pike	Sandstone	J. S. Cline	2.47	154.3	1— 87	6.1	Meets specifications all classes.
Powell	Limestone	Thos. Chaney	2.62	163.7	1—487	3.4	Meets specifications all classes.
Powell	Limestone	J. C. Patrick	2.73	170.6	1—484	4.4	Meets specifications all classes.
Pulaski	Limestone	T. Wheller	2.65	165.6	1— 83.4	5.3	Meets specifications all classes.
Pulaski	Limestone	C. Pagget	2.70	168.7	1—379	5.8	Meets specifications all classes.
Rockcastle	Limestone	Sta. 81, F. A. 70-F	2.53	158.1	1—209	4.9	Meets specifications all classes.
Rockcastle	Limestone	John Guinn	2.66	166.25	1—300	4.9	Meets specifications all classes.
Spencer	Limestone	G. E. Jones	2.80	175.	1—225	5.4	Meets specifications all classes.
Trigg	Limestone	N. C. Headley	2.80	175.	1—403	3.3	Meets specifications all classes.
Trigg	Limestone	W. C. White	2.60	162.5	1—405	3.6	Meets specifications all classes.
Webster	Limestone	D. B. Gore	2.75	171.8	1—143	4.5	Meets specifications all classes.
Woodford	Limestone	Starks	2.63	164.3	1—569	6.3	Meets specifications all classes.
Whitley	Sandstone	J. Carson	2.47	154.3	1— 50	4.6	Meets specifications for base course.
Whitley	Sandstone	O. Siler	2.52	157.5	1— 67	5.3	Meets specifications for base course.

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